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EXPERIMENTAL RESEARCHES UPON RIVER NAVIGATION MATERIEL.

THE theoretical notions that we possess as to the resistance of fluids are insufficient for calculating the stress necessary for the movement of a vessel in water.

As regards ocean vessels, the experimental study of the resistance of keels has given rise, in various countries, to numerous and important works; but, as concerns boats for interior navigation, it has, so to speak, not been entered upon.

It does not seem possible, however, *a priori*, to apply the results obtained with ocean vessels to boats for river navigation. The former have curved lines, while the latter present a long rectangular part comprised between two more or less pointed extremities of but slight length. On another hand, the experiments upon ocean vessels are made under very great speeds. It is rare that speeds less than six knots are considered therein, while such speed may, on the contrary, be considered as a maximum for the *materiel* of interior navigation.

Special experiments therefore appear to be indispensable with a view to ascertaining whether the forms at present given to river boats are indeed those best adapted for a rational and economical exploitation, and, in the contrary case, to determining the modifications that it would be advantageous to introduce therein. This was the object of the researches Richards Brothers at the top of the Eiffel tower, and which inscribes the real velocities of the wind upon a cinemograph established in the Central Meteorological Bureau.

The manometer and cinemograph register all the variations in stress and velocity simultaneously. When, during a period of time sufficiently long, both have remained constant (this being shown by the horizontality of the lines traced upon the registering apparatus), it may be concluded that the stress is indeed eye. At right angles with the frame thus formed is placed a second frame consisting of two steel cross pieces, one of which carries the piston, while to the center of the other is fixed a strong trace hook. By means of a cable passing into the eye of the upper cross piece, the first frame is attached to the boat, while the second is attached to the tug by the trace hook. In this way, all the tractive stress is transmitted integrally to the water contained in the cylinder of the apparatus.

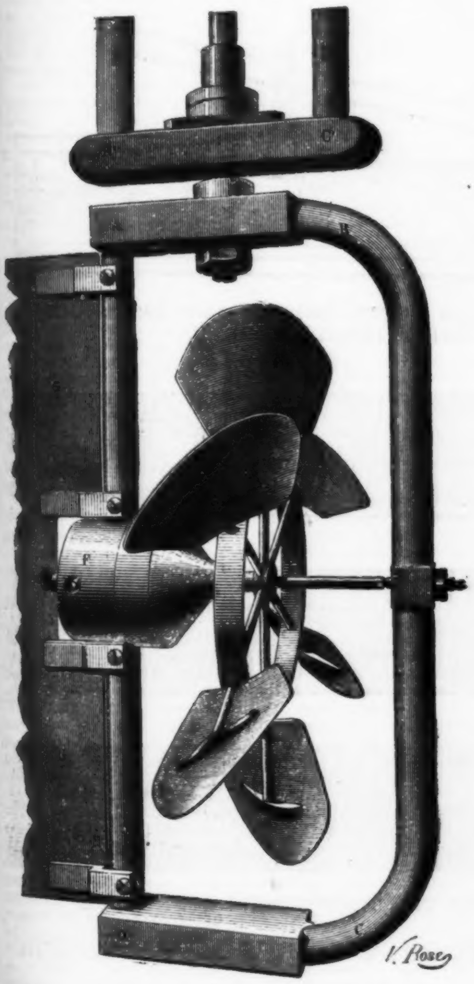
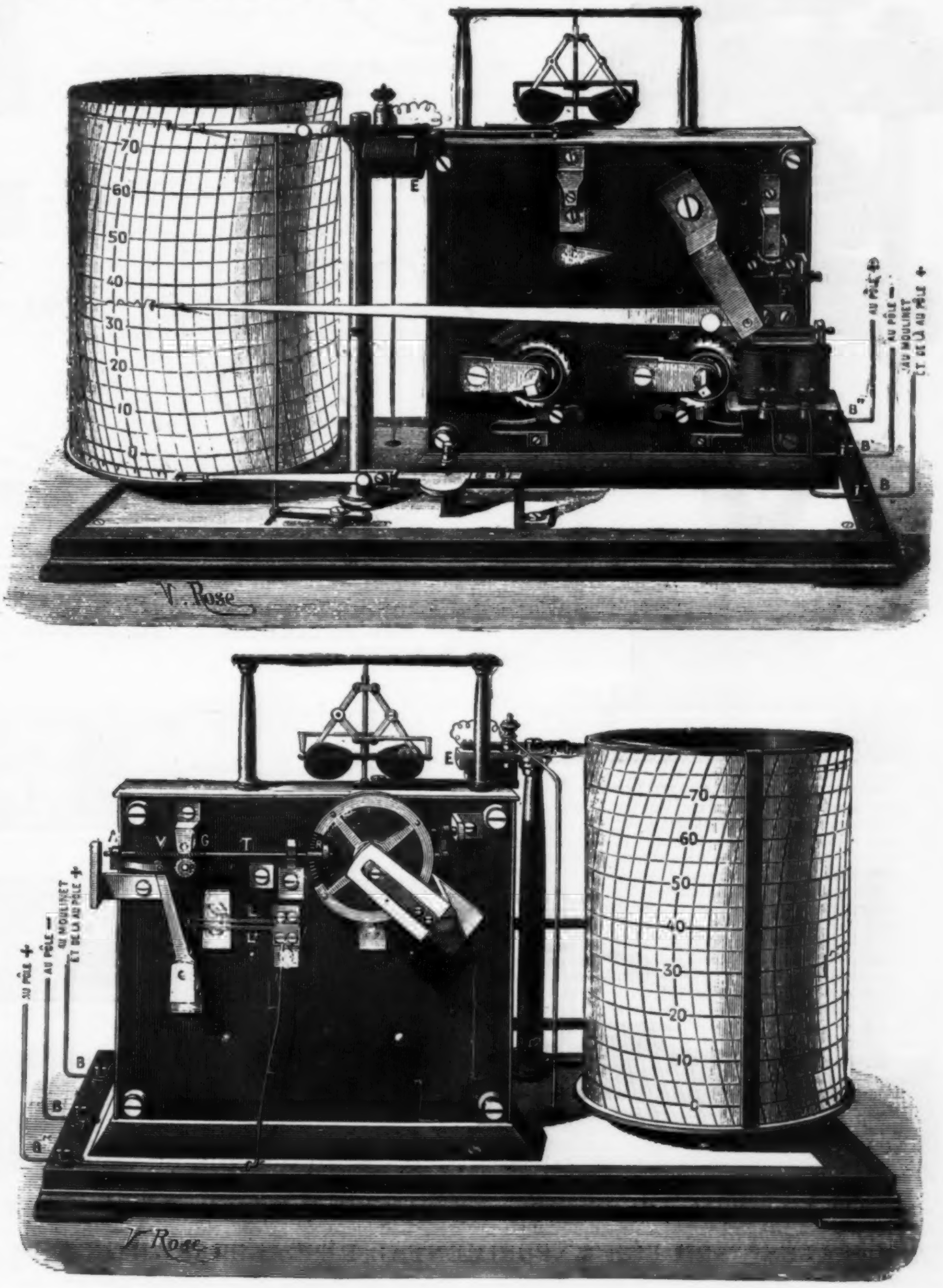


FIG. 6.—ROTARY APPARATUS.



FIGS. 10 AND 11.—FRONT AND BACK VIEWS OF THE CINEMOGRAPH.

APPARATUS USED FOR EXPERIMENTAL RESEARCHES UPON THE MATERIEL OF RIVER NAVIGATION.

undertaken by Mr. De Mas, government engineer in chief, with the approbation and at the expense of the minister of public works. The experimenter operated by way of direct towing. The instruments employed are so well combined that they give on the one hand, at every instant, the tractive stress exerted upon the boat towed, and, on the other, the real relative velocity of the boat and the water.

The tractive stress is exerted through the intermedium of a hydraulic dynamometer. The pressure of the water is measured with a Richards registering manometer.

In order to determine the velocity of the water with respect to the boat, an apparatus is employed that is in all respects like the anemometer installed by the that which corresponds to the velocity. We have therefore the co-ordinates of a point of the curve of total resistance constructed with the velocities as abscissas and the tractive stresses as co-ordinates.

Before making known the general results of these experiments, we shall describe each of the apparatus that was employed.

The hydraulic dynamometer arranged for the measurement of the resistance to traction consists essentially (Fig. 1) of a steel cylinder full of water, closed at the top with sheet rubber, against which bears a piston of the same diameter as the interior of the cylinder. Two metallic rods are bolted on the one hand to the plate in which the cylinder rests, and, on the other, to a steel cross piece provided with an

The whole forms an apparatus manageable without precaution and very sensitive. In order to reduce to a strict minimum the friction resulting from the guiding of the piston and to prevent gripings in its head, it possesses the diameter of the cylinder only, for a very feeble length. Besides, its upper guide consists of a spherical piece carried by the cross piece provided with an eye and sliding upon a simple line of contact in the orifice of the subjacent cross piece. Finally, in two recesses in the cylinder plate engage very freely the cross pieces of the piston, so as to keep the two frames at right angles.

The dynamometer thus obtained is at once very strong and very sensitive. It is connected by a copper tube of small diameter with a registering manometer,

of the Richards type (Fig. 3). Although this apparatus is in wide use, we shall recall the principal arrangements of it. Its essential part is a metallic tube of elliptical section fixed at one extremity and free at the other, and recalling the form of an interrogation point. The pressure to be measured, acting in the interior of the tube, tends to diminish the ellipticity of the section. There result in its *ensemble* distortions to which correspond displacements of its free extremity, which, amplified by a play of levers, are shown by the oscillations of a needle which inscribes them upon a cylinder moved by an interior wheelwork.

Upon this cylinder is wound a sheet of section paper, which is fixed by a screw placed in a recess. The horizontal lines of the ruling are spaced two millimeters apart; the others are equidistant, parallel curves corresponding to the trace that the oscillations of the extremity of the large needle would leave upon the cylinder supposed immovable.

needle corresponding to a variation of 100 kilogrammes in the total stress are respectively 0·005 and 0·002 meter.

For connecting the dynamometer with the manometer there are employed copper tubes 0·003 meter in internal diameter, twisted into a spiral in order to give them elasticity. The couplings (Fig. 4) are rendered tight by means of the following arrangements:

At the end of the tubulure, T, there is a thread and a screw socket, D, whose base is freely traversed at O by the coupling tube, *t*, terminating in a junction thread. Upon tightening, a small rubber washer, *r*, placed beforehand upon the end, B, with circular grooves, assures through its compression the tightness of this joint and expands into the groove, *e*. Finally, the jam nuts, E E', prevent torsion at the moment of tightening.

Serious difficulties presented themselves in the filling of the manometer, which must be taken apart after each experiment and filled anew. Fig. 5 shows how these were surmounted.

(Fig. 6), 32 centimeters in diameter, has six aluminum plate blades of 1 millimeter, forming a screw of 1 meter pitch, and weighs but 438 grammes. Its axis is carried upon points through the vertical frame, A, B, C, D, which is itself suspended by means of a freely rotating rod from another frame, A', B', C', D', fixed in front of the boat.

The lower frame carries an iron plate rudder, and is capable of turning at the call of the current, so that the shaft of the screw is always horizontally in the direction of the current. To every revolution of the screw there corresponds a certain number of interruptions of an electric current. To this effect, there is keyed upon the shaft a disk, upon whose undulated circumference (Fig. 7) bears a small roller, *g*, connected with a flat spring, *r*, whose point, *p*, comes in contact with the metallic plate, *r'*, at every passage of an undulation of the disk. As *r* and *r'*, insulated from each other, are placed in the circuit of a battery, it follows that the current is interrupted at every revolution of

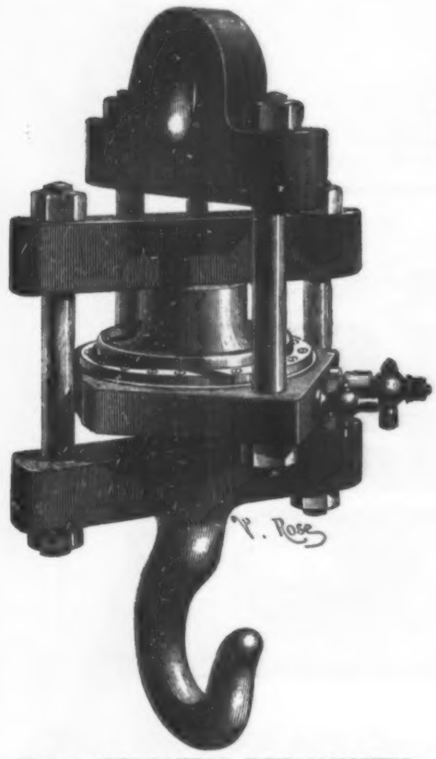


FIG. 1.—HYDRAULIC DYNAMOMETER.

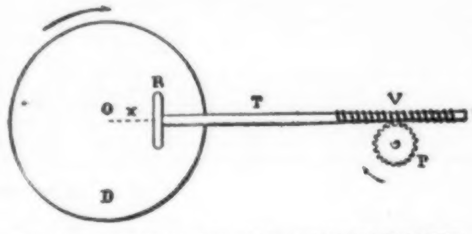


FIG. 9.—THEORY OF THE CINEMOGRAPH.

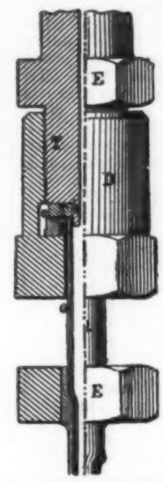


FIG. 4.—TUBE COUPLING.

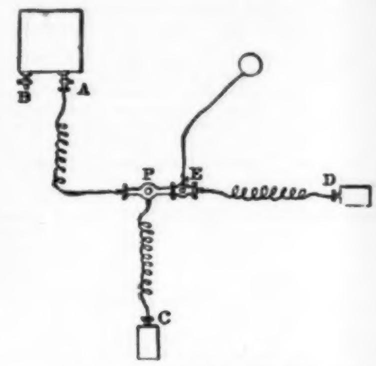


FIG. 5.—FILLING OF THE DYNAMOMETER.

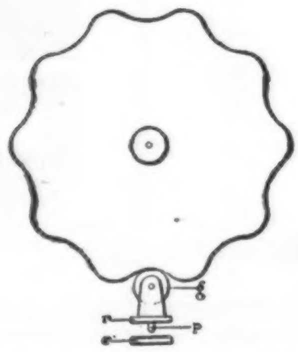


FIG. 7.—UNDULATE DISK OF THE ROTARY APPARATUS.

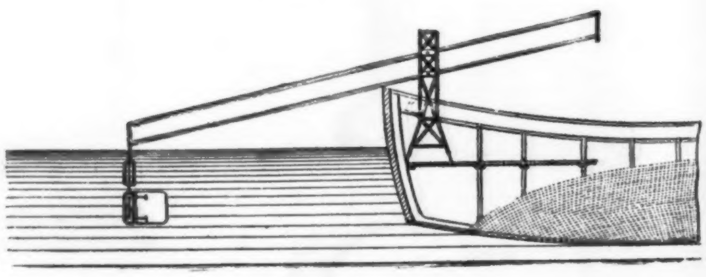


FIG. 8.—INSTALLATION OF THE ROTARY APPARATUS UPON A JOINTED PARALLELOGRAM.

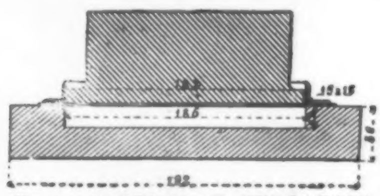


FIG. 2.—SECTION OF HYDRAULIC DYNAMOMETER.

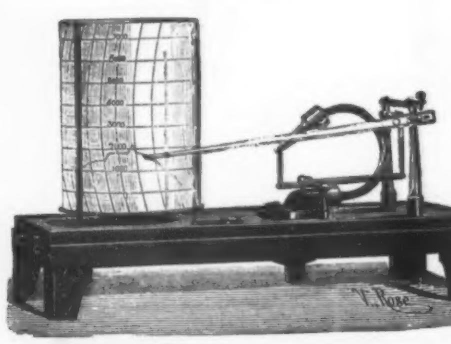
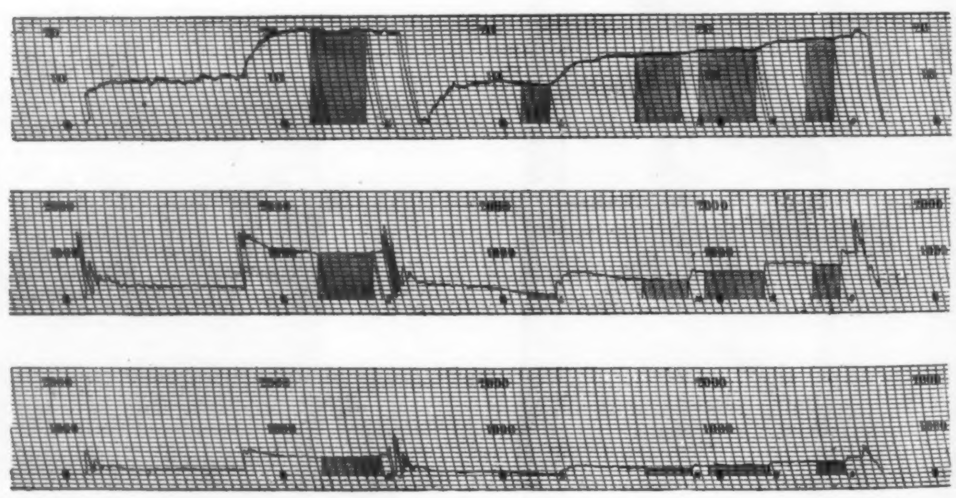


FIG. 3.—REGISTERING MANOMETER.



FIGS. 12, 13, AND 14.—CURVES TAKEN UPON THE REGISTERING APPARATUS.

APPARATUS USED FOR EXPERIMENTAL RESEARCHES UPON THE MATERIEL OF RIVER NAVIGATION.

The interval between the curved lines corresponds to a fraction of the duration of the revolution of the cylinder, four minutes in space.

The relation that exists between the stress exerted upon the dynamometer and the indications of the manometer is:

$$F = p\,S,$$

where F designates the stress in kilogrammes exerted upon the dynamometer, S the surface of the piston or of the cylinder in square centimeters, and p the pressure upon the liquid in kilogrammes per square centimeter.

Of the two manometers employed in the experiments, the smaller is capable of measuring pressures per square centimeter of from 0 to 20·7 kilogrammes, corresponding to total stresses of from 0 to 3,000 kilogrammes, and the larger of pressures per square centimeter up to 55 kilogrammes, that is to say, stresses reaching 8,000 kilogrammes. The levers of these apparatus are so calculated that the displacements of the

Of the two tubulures with cocks, of the dynamometer, one, B, is a blow-off cock, and the other is connected with a bronze collector, P, from which start two conduits running respectively to the tube of each dynamometer. This collector carries a three-way cock and a tubulure with a cock, E, which a rubber tube connects with a small portable force pump. After this piping has been established, the joint, A, is tightened hermetically, but the couplings, C and D, of the manometers incompletely. Besides, the cocks, B and E, are opened. When the pump is sending a continuous current of water, the air escapes through B, C, and D, at first in small bubbles, and then in larger ones. Soon no more air remains. At this moment the joints, C and D, are tightened, while the pumping is slowly continued. It remains to allow a little of the liquid to flow through E, in order to bring the manometers to zero.

We have said above that the relative speed of the boat and the liquid is determined by means of a rotary apparatus submerged in the latter. This apparatus

the screw as many times as the circumference of the disk presents depressions.

Despite its lightness, this apparatus has frames that are particularly strong, so as to be able to withstand great stresses and shocks.

After many experiments, it was decided to install it as shown in Fig. 8. This mounting puts it far enough from the boat to prevent the relative speed from being altered, and permits of removing it from the water at will. It consists of a latticed iron frame, carrying a jointed parallelogram provided at its base with lengthening bars that permit of establishing it perpendicularly. The small sides of this parallelogram remain vertical in all positions. It is from the posterior one that is suspended the screw, whose frames must also always be upon the vertical.

The cinemograph, which completes this installation, is represented in the diagram shown in Fig. 9. A rod, T, carries a wheel, R, and an endless screw, that gears with a pinion, P, actuated electrically by the screw of the rotary apparatus. Every time the screw makes a

determinate fraction of a revolution that corresponds to a certain displacement with respect to the water, the pinion, P, turns by one tooth from left to right and displaces toward the right the screw, V, and the wheel, R, which bear against the disk, D, set in uniform rotation by a clockwork. This motion is transmitted to the wheel, R, and the rod, T, and thus unscrews the latter from the nut formed by the pinion, P, and this tends to constantly displace the entire system, R, T, V, toward the left, and to bring back to the center, O, of the disk the point of contact of the wheel, R, with the latter. This disk is thus submitted to two contrary actions. It seeks, therefore, upon the disk, D, a position of stable equilibrium, for which it is easy to see that the distance, x, from R to O, is exactly proportional to the rotary velocity of the pinion, P.

In fact, let ω be the angular velocity of the disk, D, x the actual distance of the wheel, R, from the center of the disk, r the radius of the wheel, and a the pitch of the screw, V. The angular velocity of R will be $\frac{\omega x}{r}$ and, in the time $\triangle t$, the revolution of this wheel will cause it to approach the point, O, by the quantity

$$(1) \qquad \frac{\omega x a}{2 \pi r} \triangle t$$

When the pinion, P, revolves, each tooth causes the screw, V, to advance toward the right by a constant length, b. If the pinion revolves at the rate of n teeth per second, the total displacement of R produced by the revolution of the pinion, P, will be in the time $\triangle t$.

$$(2) \qquad n\, b \triangle t$$

For equilibrium, the quantities (1) and (2) must be equal; then $\frac{\omega x a}{2 \pi r} = n\, b$ or $x = K\, n$, K being a constant that depends only upon the construction of the instrument.

The distance, x, is, therefore, exactly proportional to the rotary velocity of the pinion, P, that is to say, to that of the rotary apparatus that actuates it electrically. The registering of the relative velocity of the water is then reduced to that of the displacements of R or of the extremity of the screw, V. It is possible to employ a registering cylinder like that of the manometer. It suffices to cause the pen to be controlled by the extremity of this screw through a play of suitable levers.

In Figs. 10 and 11 may be seen the cinemograph, as constructed by the Richards Brothers. In reality, the wheel, R, is placed between the disks, D, revolving in opposite directions and pressed against each other by a central spring. This part thus revolves without sliding. These disks and the pinion, P, are respectively actuated by independent clockwork movements. The movement of the first is provided with a Foucault regulator; as for the second, that is provided with an escapement controlled by an electro-magnet placed in the circuit of the screw of the rotary apparatus, and visible to the right of Fig. 10. It will be remarked that this pinion (Fig. 11) is provided with a roller, G. The registering cylinder receives the inscriptions of three styles whose extremities correspond exactly to the same curvilinear ordinate of the section paper.

It is the large intermediate style that inscribes the relative velocity of the water. It is controlled by a lever jointed at A to the rod, T. The upper style traces a line every time that a definite space has been traversed. It is actuated by a second electro-magnet, E. Finally, the lower style is accessory, and obeys the finger of the observer for the marking of a datum point.

The upper style is attracted in a downward direction when the circuit is closed, and resumes its initial position as soon as the circuit is interrupted. The mechanism that effects the alternate closings is seen in Fig. 11. Of the two horizontal springs, L L', one, L', isolated, communicates with one of the poles of the battery through the terminal, B", and the other with the other pole through the wire of the electro-magnet, E, and the terminal, B'. Normally, the two springs are separated and the current is interrupted. Above the upper spring will be seen a small cam whose shaft is connected by gearings with that of the pinion, P. The cam makes one complete revolution for 124·8 revolutions of the pinion, and at every half revolution it bears against the upper spring. In its passage, a contact is established between the two springs, the circuit remains closed for an instant, and the upper style inscribes a line upon the registering cylinder.

As the blades form a screw of one meter pitch, one revolution of the latter corresponds theoretically to a space of one meter traversed. As the disk keyed upon the shaft has twenty projections, the screw sends a current into the electro-magnet actuating the pinion, P, at every twentieth of a revolution every time that the water has traversed 0·05 meter. The relative velocity of the water corresponding to a velocity of the pinion, P, of n teeth per second is, therefore, theoretically, $n \times 0{\cdot}05$ meter, say one meter for twenty teeth per second. The ratios of the levers that control the style of the registering apparatus are so calculated that for such velocity of one meter per second the vertical displacement of the style shall be 0·02 meter.

By means of the upper style, we may know the mean velocity of the water during a certain period, or the total space traversed during such period of time, for it marks a line upon the cylinder every time the water has traversed 62·4 meters. It suffices, therefore, to count the lines marked in a given time.

The cinemograph is regulated mechanically independent of the rotary apparatus, so that there are no other errors to be feared than those due to the rotary apparatus itself. The determination of such errors has formed the subject of a careful study, into the details of which we cannot enter.—*Revue Industrielle.*

THE steam power of the world is placed at 49,000,000 horse power. This is equivalent to the working capacity of 1,000,000,000 men, which is more than double the total working population.

[FROM ENGINEERING.]

UNDERPINNING BY MEANS OF GROUTING AND STOCK RAMMING.*

By WALTER ROBERT KINIPPLE, M. Inst. C.E.

IN my lectures to the Royal Engineers at Chatham, to which I have already made reference, I gave a brief description of the monolithic system of construction. I adopted it in the extension of the Hermitage Breakwater at Jersey, and which proved so successful as regards reduced cost, rapidity of execution, and soundness of work obtained, but as the present articles have reference more especially to repairs to and securing the stability of existing works, I shall now describe what has recently been done with respect to securing a portion of that breakwater constructed prior to 1877 under Sir John Coode, which will, I think, show very clearly the advantages and simplicity of the grouting system, and how well suited it is to render secure existing structures.

Figs. 6 and 7 are elevations of the sea and harbor faces respectively of the Hermitage Breakwater, from the Hermitage rock seaward, and Figs. 8, 9 and 10 are cross sections of that work. The shallower or landward portion of average length of about 560 ft. represents what was constructed under Sir John Coode prior to 1877. The seaward or deep portion of 525 ft. in length represents what was constructed in accordance with my design, between the years 1887 and 1889.

It will be seen from the engravings, Figs. 8 and 11, that the work carried out under me is monolithic from foundation to cope, consisting first of a foundation bed, on top of the rock, formed of rubble and shingle grouted into a solid mass with thick neat Portland cement grout, and leveled off on its upper surface for the reception of the blocks after the bed had firmly set. The blocks, which have grooves and projections, Fig. 11, are faced with granite ashlar and placed on top of the bed in inclined courses, Figs. 6 and 7. The horizontal and vertical joints between the blocks themselves, and between the first course of blocks and the foundation bed, were grouted together with neat Portland cement, thus making the entire structure with the bed one solid mass throughout, and firmly cemented to the granite rock on which it stands. In the landward portion of the work constructed under Sir John Coode, the ordinary system of construction, such as that exemplified in Madras, Colombo and Wick breakwaters, was adopted.

Figs. 9 and 10 represent cross sections of that portion of the work. It will there be seen that below low water level the preparation of a level bed for the blocks was effected in another manner. The system adopted was to use bags of concrete of sizes varying from about three tons to about a couple of hundredweights, according to the irregularities in the rocky surface, and to adjust the upper surfaces of these bags so as to get a bearing area as nearly level as possible, any gaps or spaces between the bags of concrete being filled up with broken stone or pieces of rubble, or some concrete deposited *in situ*. On top of the foundation bed thus prepared large blocks of concrete from 50 to 90 tons in weight were placed and stacked one on top of another (Fig. 9), without bond, and with spaces or joints between them in a longitudinal and transverse direction of several inches in width. These large blocks were brought up to above water level. On top of them up to coping level solid work was constructed with blocks 9 to 12 tons in weight, bedded and jointed with cement mortar. The difference between monolithic and open-jointed work was here plainly to be seen. All the upper or solidly bedded and jointed part of the work was in good order, but the lower or open-jointed work was not.

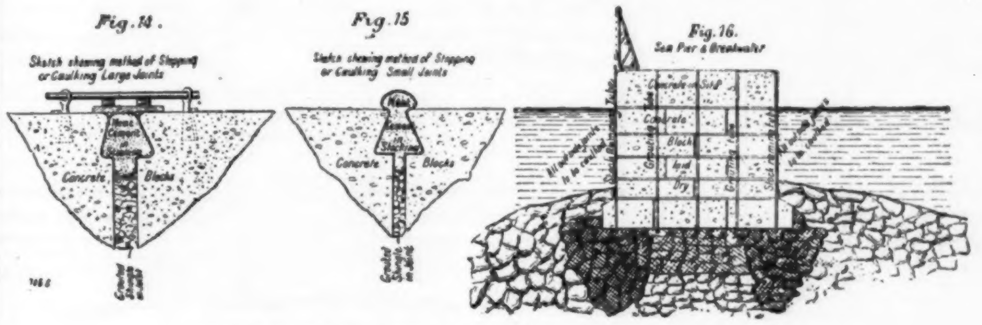
In accordance with the instructions of the Harbor Committee, I had to examine this work fully in person, and, with the aid of divers, the result of such examination revealed the fact that the 50 to 90 ton blocks at their corners and arrises had in many places suffered considerable damage from disintegration, and from the sea having free access all round each stack of these blocks. Not only so, but the divers reported to me that from the foundation area many of the smaller bags, the whole of the broken stone and some of the rubble and concrete filling between, had been washed out by the action of the sea, leaving cavities in some cases large enough to admit of a diver getting underneath the foundation course of blocks (see Fig. 10). I did not consider it safe that the work should remain in that condition, with the probability of getting worse; so I recommended that this lower open-jointed portion should, like the upper portion, be made solid or monolithic, and in order to convert it into this class of work, I adopted the method I was using for the construction of the deep water extension of the breakwater, and with the most successful results.

As a detailed description of what was done might be of service to other engineers somewhat similarly circumstanced, I herewith give it as follows, viz.:

All the vertical and horizontal joints in the face of the work had to be stopped or rendered cement-tight before grouting was commenced, in order to prevent the escape of cement. Various methods were adopted, according to the widths of the joints; thus, for the horizontal joints, I, I, I, Fig. 9, between the large blocks which were comparatively close, canvas bagging was forced a few inches into the joints and calked in firmly, similarly to calking ordinary seams of plankings. The vertical joints, J, J, J, Figs. 6 and 7, between the blocks were wide, varying from about 2 in. to 6 in., and these widths in many cases had to be increased considerably by cutting away loose and deteriorated portions of the blocks. When such deteriorated portions had been cut away, the joints where the stopping was to be placed were trimmed down vertically and slightly dovetailed, in order to give a hold for the stopping (see sketches, Figs. 14 and 15). For the narrower joints (see Fig. 15), 2 in. to 4 in. in width, cement paste filled into thin canvas cases or stockings, making rolls of about 6 in. in diameter, proved very serviceable, as they could be partly filled with cement and lowered down the prepared joints and afterward filled up with cement, which was rammed down solid while it was soft into the dovetailed vertical grooves, and when set made a capital stopping. Where the joints were wider, larger cases were inserted into the dovetailed grooves and a facing plank was held in position by a bar, and lewis eye bolts, to prevent the bag from spreading out in the face, as shown on Fig. 14. For still wider joints up to as much as 2 ft. when the sides were dressed down, small bags of neat cement in a plastic state were stacked solidly on top of each other and jammed tightly in to fill up the dovetailed spaces, and also the joints between the bags, and any irregularities on the surface of the rock at foundation level. When the calking was completed, grouting was commenced at the lower level next the new monolithic portion, and extended shoreward until the whole of the work up to the under side (Figs. 9 and 10) of the solid portion of the structure, that is up to the under side of the work which had been filled up solid below coping with cement.

Subsequently the grouting pipe, Figs. 9 and 10, was inserted in the joints of the blocks down to the foundation, and, before any cement was used, as much large shingle as possible was filled into the joints, after which the cement was passed down in the form of a thick grout or paste through wrought iron pipes 3 in. in diameter. The grout was prepared on the surface of the breakwater, and poured into the funnel-shaped mouth at the head of the pipe, which was carried up the side of the breakwater to the top thereof. At intervals along both sides of the breakwater, holes or spaces in the joints immediately behind the vertical stoppings had been left for the insertion of the lower end of the grouting pipe and shingle, and into these holes the pipe was successively placed when a sufficient quantity of grout had been passed down at each joint. During the operation of grouting the divers examined all the joints, to see if there was leakage of cement at any point, and wherever leaks were found they were easily made tight by a calking of canvas sacking. This was the work of but a few minutes. The grout which was passed through the pipe found its way into all crevices, and filled up large and small spaces alike. The work was thus rendered thoroughly solid throughout, and of the quality of the cement when set there can be no question, as specimens of it were brought up by the diver from time to time to submit to the harbor committee; some of these specimens I have still in my possession, and these are splendid examples of underwater grouted work. The cement grout, on being put into the pipe, displaced the water therein by forcing it out at the lower end of the pipe, as the grout was added, and thus a mass of grout without mixing with the water forced its way out from the bottom of the pipe in all directions (as shown by the arrows on Fig. 9) by its head, or pressure in the pipe, filling up all the lower interstices first, and then rising or spreading upward until all the interstices at the higher levels were filled up solid. I have always considered it advantageous to keep the travel or spread of the grout within narrow limits, and generally speaking in my practice have kept the grouting holes for the pipe at intervals of 5 ft. to 10 ft. apart, but in the grouting of this breakwater, where the grout had a head of about 50 ft. in the pipe, or about 50 lb. per square inch, it traveled down the pipe from the top of the breakwater to the foundation, across from one side of the breakwater to the other, a distance of about 40 ft., and then rose vertically through several feet of shingle, and driving the water out up to M M. Yet after having traveled 100 ft., specimens of it which were broken off at M M showed that the cement had set into a hard, sound mass throughout. Such good results would probably not have been obtained without the use of really first class finely ground cement properly mixed and sufficiently thick to drive out the water from all interstices in the foundations as it advanced from one side of the breakwater to the other.

I have found fine grinding to be of great importance, and in the Jersey works the cement used had to pass through a sieve of 6,400 meshes to the square inch, and one batch was passed through a sieve of 10,000 meshes. If the cement was new it set quicker in water, which in some respects was an advantage, but in all cases



IMPROVED METHOD OF UNDERPINNING.

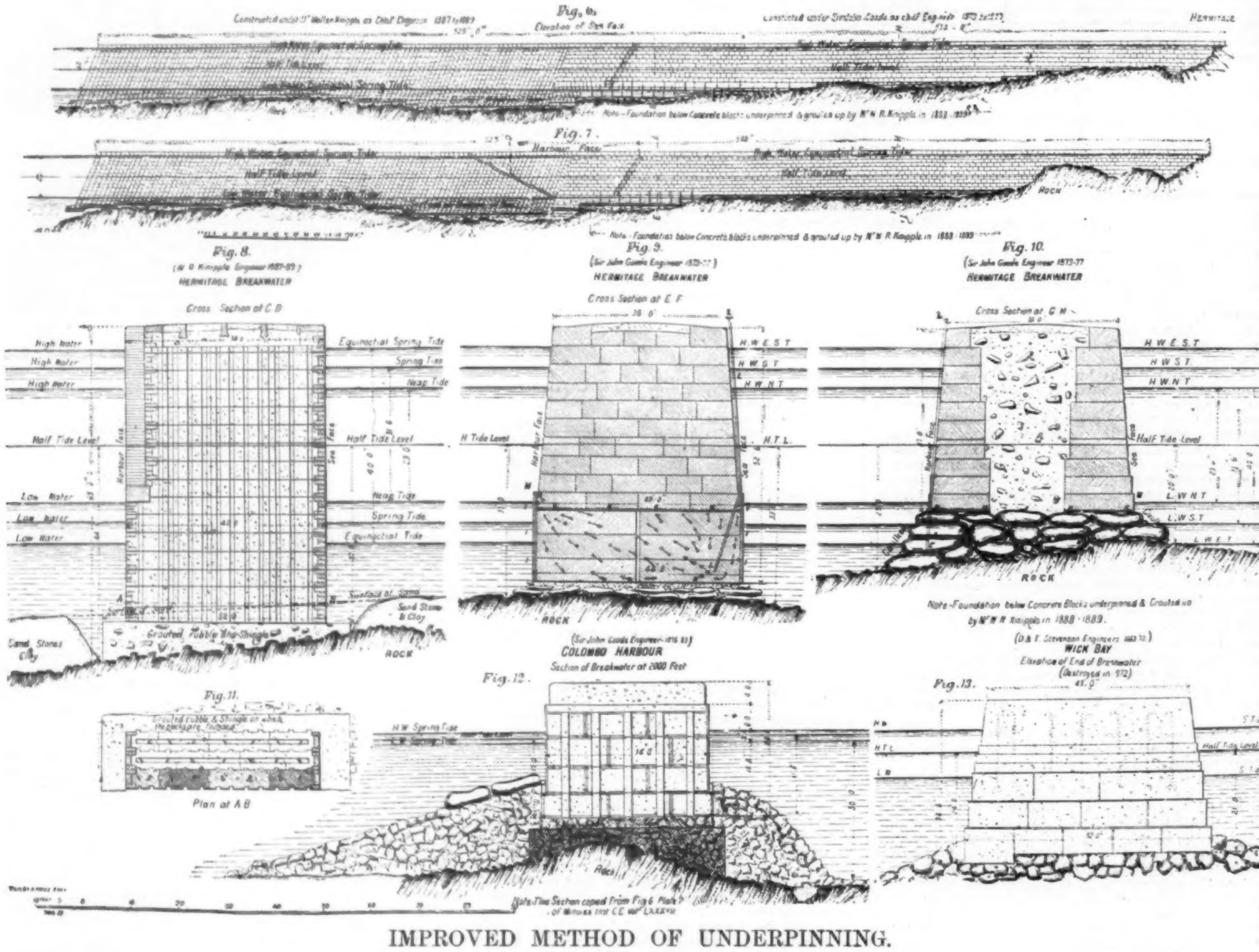
* Continued from SUPPLEMENT, No. 872, page 13935.

cement paste, or grout, used in this manner takes much longer to set in water than out of water. The paste or grout should be mixed up as stiff as it can pass or be forced through the pipe, and in the preparation of it the operation to be pursued is to place a certain quantity of dry cement on a mortar mixing board, add some water to it, and continue adding a little water at a time while turning over the cement until a stiff paste is obtained. The opposite course of preparing the grout by taking a tub of water, adding cement thereto, stirring, and gradually adding cement until a stiff paste is obtained, is wrong in principle, and from my experience a grout so mixed gives either inferior results or ends in complete failure. The cost of rendering solid, and thus making perfectly secure, the under portion of the older portion of the Hermitage Breakwater by grouting was about 1,200*l*., 400*l*. of which was for cement and 800*l*. for wages of divers and other workmen. For this small sum an important and costly work was rendered safe, and I think, in cases of other works constructed after a somewhat similar type, it would only be judicious to render them equally secure by converting their disjointed masses into a monolithic structure, and thus present to the action of the sea the resistance of a solid reef instead of a pile of more or less loose materials.

As illustrative of my meaning I have represented, by Figs. 12 and 13, sections of Wick and Colombo breakwaters. I might also have added Madras, but as it is of the same general type as Colombo, the latter monoliths by means of grouting (see Fig. 16). It would not be necessary to grout up the entire mass of rubble on which they stand, as measures could be taken to limit the grouting of such to what would be required and nothing more, that is by ramming down partly set neat Portland cement so as to form a base and margin of Portland cement as shown, after which the interstices in the rubble mound immediately under the heart of the breakwater and joints of the blocks could be grouted up.

In speaking of Madras, Colombo, and Wick breakwaters, I merely refer to them as well known works and representative types of the rubble base, dry block, and concrete capped system of construction which has been so generally in use during the last thirty years. Any other similar works would have served my purpose equally well for directing attention to a type of construction which, in the light of what is now being done in the direction of indestructible and monolithic work, should be regarded as obsolete, but which, in spite of failures, is unfortunately not yet so considered. Further failures may, it is feared, reasonably be looked for if this type of construction is continued. It is somewhat gratifying to me (the inventor of the grouting system) to know that within the past few years this method of executing work has been adopted by many engineers, more especially by those engaged in harbor works.

Since my experiments in 1856, I have strongly advocated this system, used it in my own practice, and



IMPROVED METHOD OF UNDERPINNING.

will suffice. How much better would it have been had one or more lower tiers of blocks been added to the Colombo Breakwater, and thus have founded it on a solid base of grouted rubble or shingle directly on the rock, as in the extension of the Hermitage Breakwater. The base of the breakwater could then have been cemented directly to the rock wherever desired. It would have been both cheaper and better. The etched dark central portion, Fig. 12, represents the extra quantity of concrete block and grouted rubble to form such a solid base, while the base of loose rubble, spread out over the rock foundation on each side for a considerable width as shown, could have been dispensed with. In somewhat greater depths of water, even where founded in sand, the economy would have been greater, as the solid base would have remained of practically the same width, while the sloping rubble base must of necessity have been spread out to a greater width. A breakwater founded on the top of a base of grouted up rubble and shingle, and built on the grouted block system, would be a monolith or solid throughout, whereas by the dry block system, even although grooves and joggles be used, the strength of the structure for all practical purposes may be taken as that of one of the blocks, at the same time having all the objections of open joints exposed to the heaviest seas. Hence there have been failures at Madras and at Wick, failures which could not have taken place had these structures been monolithic. And to guard against further failures at Madras, and any risk of failure at Colombo, it would only be wise, in my opinion, to convert these two latter structures into by descriptions of it in the minutes of the Institution of Civil Engineers and in engineering journals, have endeavored to make it well known. Apparently, however, that has not prevented others from imagining within the past few years that they had invented something quite new; and even so recently as last year it was stated in *The Engineer* that a German engineer had taken out a patent for obtaining solid work under water by means of grouting, although, as may be seen from past records, at the time of this so-called new invention the system was at least thirty-three years old.

Prejudice against grouting, although in many cases still strong, is really due to want of knowledge; but in face of the successful works which have been executed by its means, and the more extended application which is now being made, especially in connection with breakwater construction, it will soon supersede the unreliable dry block and rubble base system now so much in use.

UTILIZATION OF THE ENERGY OF FLOWING WATER.

MESSRS. PURDON & WALTERS lately read a paper before the British Association. The authors have invented a motor which is designed to convert the energy of flowing water into mechanical power for the purpose of driving electric, pumping, grinding, and other plant. The machinery of the motor is carried on a pontoon, below which is a lower deck or platform attached to it by uprights. When at work the motor is moored at right angles to the direction of the current, and adjusts itself automatically to the varying levels of flood or tide. The lower platform covers in the moving parts and provides for the motor taking the ground without damage in shallow water, and even being worked in that condition. The mechanism acted upon by the water consists of blades fixed at even intervals to an endless chain passing over two vertical end wheels, the links of the chain gearing with flat surfaces provided on the wheels. The bearings for the wheel shafts are placed at such a level on the pontoon that half the chain and blades, controlled by fixed guiding rollers, are submerged in the water, while the other half are suspended in the air.

The back portion of the pontoon is constructed with a water-tight deck interposed between the end wheels and the upper and lower parts of the chain, so that when motion is imparted to the chain the blades which are submerged have a clear passage through the water between the lower platform and the pontoon, and return in the air above it. The remaining portion of the pontoon for carrying the gearing and machinery to be driven is in the form of an open barge, covered with light shedding where required and boarded up fore and aft, outside the end wheels, from the lower platform, to protect the blades in the water and to permit of the motor being towed. The space between the pontoon and lower platform through which the current has to pass from the front of the motor to the blades at the back is in the form of a bell mouth, contracted laterally by means of curved wing vanes placed at each end, and vertically by the inclination of the bottom of the pontoon and the lower platform. In this space the current is diverted into the line of action of the blades, at right angles to the stream, by means of curved guide vanes; and the blades are also curved to receive the pressure and allow of a free escape of the water into the open stream beyond. The whole arrangement is, in fact, that of the well known turbine rod.

The bell mouth has the effect of concentrating the energy of a large sectional area of stream at a higher velocity than its natural flow on a comparatively small blade area, the advantage obtained being that the weight of the moving chain and consequent friction is considerably reduced, and the speed of the chain increased. The action of the machinery impelled by the current is as follows: The current impinging on the blades forces those in the water forward with the chain which revolves the end wheels and carries round the blades each in turn, to be submerged and acted upon by the water. One of the end wheels is provided with spur gearing revolving a second motion shaft, from which any higher speed can be obtained by the employment of pulleys and belting.

Assuming a pontoon 40 ft. long with a sectional area of 151·6 square feet, where the water enters the bell mouth opening, and that the motor shows an efficiency of 25 per cent., which it is fully expected, from results obtained from an experimental machine moored in the tideway of the Thames, will be the case, the theoretical horse power of the stream and that developed

by the motor at various velocities would be approximately as under:

Velocity of stream.		Horse power of stream.	Horse power of a machine at 25 per cent. efficiency.
Miles per hour.	Feet per second.		
1	1·467	0·84	—
2	2·933	6·74	1·68
3	4·4	22·75	5·68
4	5·867	53·94	13·48
5	7·333	105·29	26·32
6	8·8	182·02	45·50

It is obvious from this table that the cost per horse power depends almost entirely upon the velocity of the current, as the capital outlay, attendance, etc., would be nearly constant. It should also be observed that where considerable power is required the motors can be placed in series at near intervals, and the cost of attendance further reduced. In deciding whether any particular stream or estuary is suitable for the use of this motor with advantage, compared with heat engines, it should be remarked that most available figures referring to the working cost of these engines are based upon a day of ten hours, whereas the water motor can be worked with very little attention, even in a tideway, for a greater number of hours, and in a river perpetually.

FAHRIG'S ELECTROSTATIC PROCESS FOR THE MANUFACTURE OF OZONE.

OZONE was first discovered by Van Marum a century or more ago, but it was first investigated and brought prominently to the notice of medical and scientific men by Schonbein, of Germany, in 1845. From that date to the present it has been a subject of active study by scientists, sanitarians and medical men generally. Ozone seems to exist in a minute quantity in the atmosphere, and how it is formed there and the conditions of its existence have long been matters of dispute. Schonbein, Andrews in England and Houzeau in France were the earlier and important exponents of the view that ozone is a normal constituent of the atmosphere. In a valuable monograph published in Germany in 1879 Prof. Engler comes to the same conclusion. On the other hand, however, the Russian chemist, Schoene, after a long series of observations and laboratory experiments, concludes that the effects ascribed to ozone in the air are due, not to that substance, but to another strong oxidizing agent, hydrogen peroxide. This view is shared by others of the present time, while several careful experimenters seem to deny the presence of either substance.

Ozone is best made by the passage of electricity through oxygen, and many scientists have been working upon apparatus devised for the practical preparation of it in quantity. By the slow combustion of phosphorus in moist air ozone is also formed, but only in limited amount. Various appliances in which this principle is employed have long been in use in laboratories and elsewhere for purposes of illustration.

Although fifty years ago it was clearly shown by Schonbein that ozone could be readily produced from the ordinary oxygen of the air by the passage through it of the electric spark, it is fair to presume that few, if any, of the readers of the *Western Electrician* have had an opportunity to inspect what could be very properly called an ozone factory. Such a plant exists, though, at Marseilles, Ill., and from the accompanying illustrations a very clear idea may be had as to the extent to which the project has been developed commercially in this country.

The Marseilles plant is operated in conjunction with the American Ozone Water Company, and the gas is utilized to ozonize table waters and high grade carbonated mineral waters. The two establishments, located side by side, are, however, separate, mechanically speaking, except that the ozone is delivered to the water company's plant by pipe.

The process employed in the Marseilles plant is that of Prof. Ernst Fahrig, who recently came to the United States from England for the purpose of establishing the manufacture of ozone on a large scale. The Fahrig process, in so far as the generation of the ozone from oxygen is concerned, is strictly an electrostatic one. The idea of producing ozone on a large scale was first conceived by Prof. Fahrig in 1878, while he was engaged in experimenting to produce calcium chloride directly from sodium chloride by electrolysis. Through these experiments it occurred to him that an easier way could be found to produce on a large scale a more effective bleaching agent than chloride of calcium. Ozone was well known to him, of course, through Schonbein's investigations, as the strongest oxidizing agent, and the knowledge of the influence of the electric spark upon oxygen led him to experiment with an alternating current of very high tension. In 1884 his first ozone plant was built in Manchester, England, and in 1887 a large plant, the St. Helens Ozone Works, was built in London, England. This led to the organization of an ozone syndicate, which now controls Prof. Fahrig's European patents pertaining to ozone. In 1888 Prof. Fahrig exhibited the products of the St. Helens Ozone Works, London, at the Manchester technical exhibition, where they may still be seen. In 1891 Prof. Fahrig came to this country with the view of exploiting his United States patents. The Marseilles plant was the outcome of his first negotiations in America, and it is claimed, furthermore, that it is the first plant in this country established to produce ozone for commercial purposes.

As has been already stated, in the Fahrig process the ozone is generated through the aid of electricity, the chemical portion of the process consisting chiefly in the production of the oxygen through the agency of a heated compound of peroxide of manganese and hydrate of soda and lime.

The manner in which the Fahrig process, which is extremely simple, is carried out will be better understood by reference to the diagram, Fig. 1. This cut shows the relative arrangement of all the apparatus constituting a Fahrig ozone generating equipment. In this diagram, A is a furnace consisting of eight 5 in. by 6 ft. pipes, *a a*, connected in series and placed in four rows of two over a fireplace built of fire brick in the usual way. To the first of the pipes, *a*, there is connected an air pipe, *b*, with the valve, b^1, loading from a blower, B, which is operated at a speed of 4,000 revolutions per minute and gives an air pressure of 10 in. on the U-tube, b^2. Joining the air pipe is a steam pipe, *c*, with valve, c^1, and test pipe, c^2, tapped off the main steam pipe of the boiler plant. From the outlet tube of the furnace a pipe, *d*, extends and carries the pressure gauge, d^1. This pipe branches into the test pipe, *e*, and the gas pipe, *f*, both pipes being furnished with stop valves. A hand-regulating steam valve, *g*, is provided for regulating the draught and combustion in the furnace. The gas pipe, *f*, leads to the two washer barrels, C and D.

The construction of the washers is very plain. Each is an air-tight barrel half filled with water, the supply of water being kept clean and cool by the water being forced in through pipes, *h h*, and out through the siphon pipes, *i i*, to the waste pipe, *k*. Washers, C and D, are joined by a pipe, *l*. From D a pipe, *m*, extends to the gas reservoir, E, in which the pressure is maintained by water power through the inlet pipe, *n*, and outlet pipe, *o*. A water glass is at *p* with a scale to show the height of the water in the reservoir, and *q* is a gauge to indicate the gas pressure. From the reservoir, E, a pipe, *r*, extends to the ozone generating apparatus. This consists of three ozonizing generators, F F, of which Nos. 1 and 2 are connected in multiple, with No. 3 in series. Just under the ozone generators, in boxes, G and G^1, are two specially wound and insulated converters that deliver current to the generating boxes above at a calculated electromotive force of 40,000 volts. H is an alternating dynamo of a capacity of 112 amperes at 50 volts pressure; I is the exciter dynamo. Switches, meters and regulators are placed conveniently in the ozonizing room, so that the operator can vary at will the current in the primaries of the converters, and thus change the electrical pressure in the generators.* The electromotive force obtained in the secondary coils is, as was before stated, calculated to be 40,000 volts. The secondary wires are inclosed in glass, and again in hard rubber tubing, and extend up through the tables and enter the generators through glass tubes set into the sides of the boxes. K is an apparatus for ozonizing alcoholic liquors. L L are experimental jars for the purpose of treating various liquors.

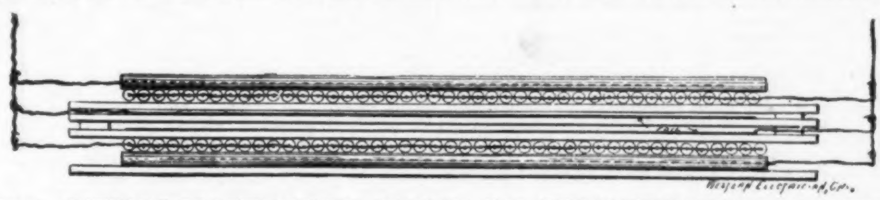


FIG. 2.—FAHRIG'S ELECTROSTATIC PROCESS FOR THE MANUFACTURE OF OZONE.

The operation of the plant is as follows: The pipes of the furnace are filled with a compound of peroxide of manganese and hydrate of soda and lime. A fire is built in the furnace and the air blower is started. When the temperature reaches 250°, the chemicals which are to act as an oxygen absorbent are ready for action. The air passing over the chemicals is decomposed, its oxygen being retained by the absorbing chemicals, while the nitrogen passes out through the waste pipe, *e*, the valve being left open. After an oxidation of 10 to 15 minutes the valves, b' and e', are closed, shutting off the air blast and closing the nitrogen pipe, c^2. The draught in the furnace is now increased, raising the temperature to about 400°. After a minute's increased heating, which causes the chemicals to give up the absorbed oxygen and leave it in a free state in the pipes, the steam valve, c', and gas valve, f', are opened far enough to obtain a steam pressure of about 15

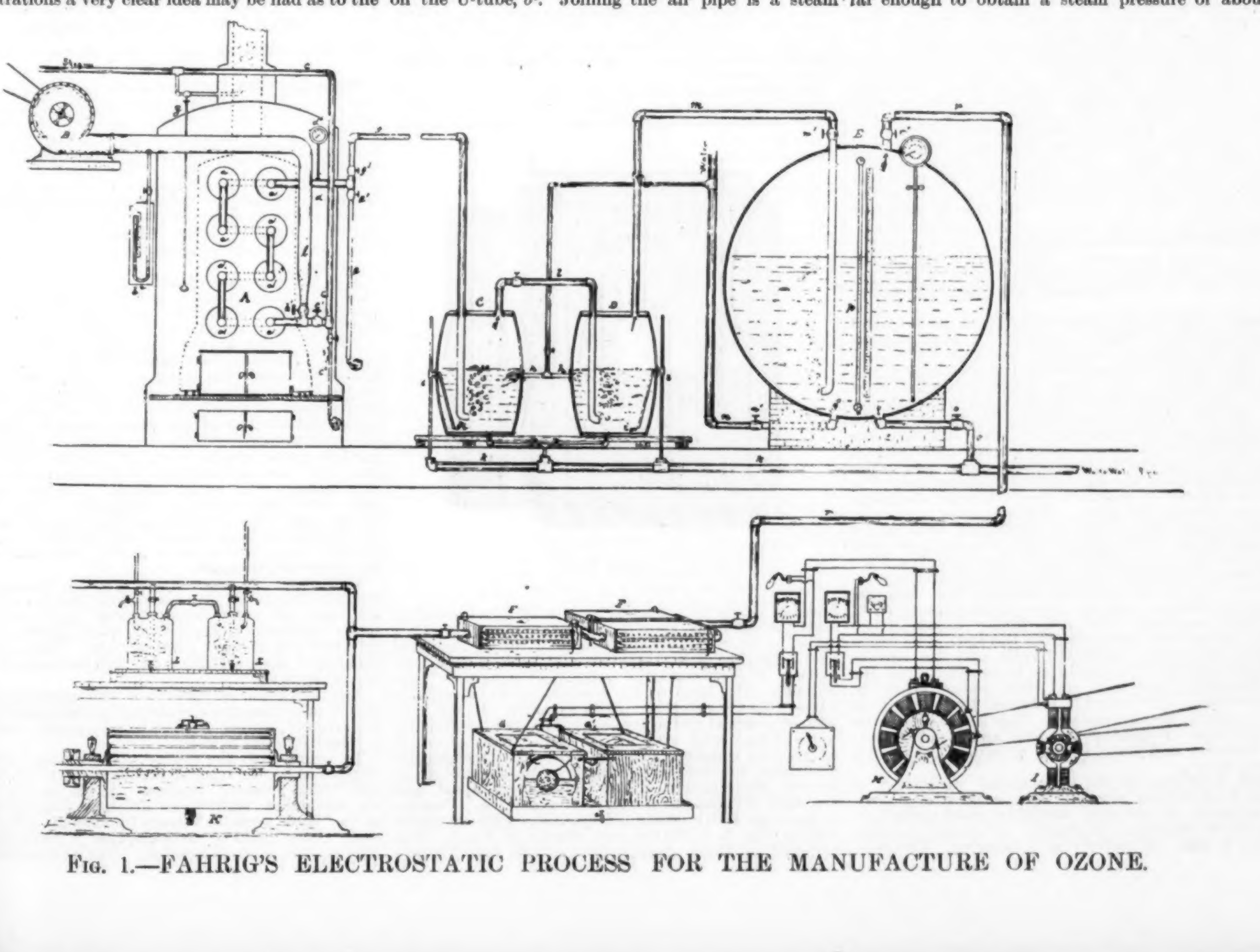


FIG. 1.—FAHRIG'S ELECTROSTATIC PROCESS FOR THE MANUFACTURE OF OZONE.

pounds per square inch. The steam, rushing through the pipes, carries the oxygen with it and carries it through pipe, *f*, to washer, C. Here the steam is condensed, leaving the free oxygen to pass to the second washer, D, for an additional cooling. From the washer the gas is carried to the reservoir, E. The valve, *o*, is opened, so that the water escapes in the same proportion at which the gas is accumulated. The oxygen is now ready for the ozone room. When from 10 to 15 cubic feet of pure oxygen have been obtained, the steam valve, *c'*, and gas valve, *f'*, are closed, the draught in the furnace reduced and the air valve, *b'*, and nitrogen valve, *e'*, opened. Now the chemicals, which have been deprived of all their oxygen, absorb fresh oxygen from the atmosphere passing over them, and after 10 to 15 minutes have elapsed the operation is repeated as before described. When a sufficient quantity of oxygen has been obtained, the gas inlet valve, *m'*, is closed and the outlet valve, *r*, opened. To create a pressure in the reservoir, the water outlet valve, *o'*, is closed and the inlet valve, *n'*, opened; the water now flows in the reservoir, forcing the oxygen out through *r* to the ozonizing generators, F F. In passing through the generators each molecule of oxygen is brought under the direct influence of the electric discharge, and is thus converted from its original state O_2 into O_3, or what is known as ozone.

The ozone generators and the converters are, from an electrical standpoint, the most important portions of the Fahrig apparatus. The transformer is simplicity itself. It is 27 inches long and has a 5 inch iron core consisting of a number of bundles of annealed iron wires. A single layer of heavy copper wire constitutes the primary coil, while the secondary is made up in five sections wound on five separate spools. Twenty pounds of No. 37 B. & S. wire were required for the secondary.

The case or box of a generator is built of wood, and measures on the outside 24 by 18 by 8 inches. The box proper is lined inside with plate glass and is made air tight with insulating cement. The generator proper is made up of plates of ¼ inch glass and glass tubes ¼ inch in diameter. The plates and the layers of tubes are arranged alternately as indicated in Fig. 2. Each tube is drawn solid at one end and contains an aluminum wire. In the generators at Marseilles two of the glass plates are pasted each on one side with a sheet of aluminum foil as shown in Fig. 2. This diagram shows also the electrical connections of a generator. It should be explained that the distances between wires and wires, wires and foil, foil and foil, foil and wires, and wires and wires, are equal. Prof. Fahrig states that the generators, although simple in construction, require the greatest care in building. In his work he had to be guided entirely by practical tests. Having proved that for the commercial production of ozone a 40,000 volt transformer gives the best result with the most economical working, the surface of the condensers, the thickness and distance between plates and wires must be found by experiment. But irrespective of the number, it may be said that the surface of the entire discharging medium being 10 by 20 inches, a five millimeters thickness and a five millimeters distance between will give the best result. The glass must be of the best quality and of as even thickness as possible. The rods must be straight and even in diameter. The aluminum foil or tinfoil and the aluminum wire must be pure, or nearly so. In building a generator, after the rods and plates have been thoroughly washed with nitric acid, rinsed in cold water and then in hot water and last in methyl spirit, they are at once coated all over with a varnish made of 20 ounces of button lac to 1 gallon of spirit fini dissolved at 120 degrees temperature; after a straining of from 12 to 15 hours it may be used with a flat 2 inch wide camel's hair brush. The rods are dipped in the varnish and receive also three coats. The sheets are cut to the size, 10 by 20 inches, leaving a 1 inch margin of glass around the sheet. Each sheet has of course a strip of foil projecting, to which the secondary wires from the generator may be attached. Before cementing the sheets to the plate glass, they are pressed against a sheet of steel netting with meshes 3 millimeters square. This fills the sheet with a great number of raised points, so to speak, that serve to direct the discharge more evenly from plate to plate. The aluminum sheet is now varnished on the underside, placed upon the glass and pressed evenly with a felted pressure board and left to dry for twenty-four hours. Then the sheet is varnished over, and when dry the plate and its conducting surface is ready to go into the generator. The thinner the foil, the better the result. The quality, too, of the varnish and the manner of varnishing form a most important part in the successful working of the generators.

After a study of the construction and the electrical connections of a Fahrig generator, a most natural question is, "Does the electrical discharge, which acts upon the oxygen flowing through the generator boxes, pass through the thick glass plates and solid glass rods?" Mr. Fahrig answers this question in the affirmative. He states that an inspection of the interior of the box during action reveals a bluish brush discharge between plates and tubes, and as the gas fed to the boxes is oxygen and that leaving the boxes is ozone, and as the electrical discharge through oxygen produces ozone, it is most reasonable to conclude that the brush discharge must be through the glass. Neither plates nor tubes, though, show any change in structure even under the microscope. It is seldom that a generator plate gives way. It is a peculiar fact, though, that if a plate does break, the crack is usually zigzag and in one direction; that is, the line of the break is from terminal corner to terminal corner. The plates, though, show no sign of puncture. The rods, if they break, invariably do so at about one inch from the end. The transformers are wound for 40,000 volts, and the current passing through the primaries is constant, but the electromotive force now and then seems nearly to double itself. This effect is detected by the pitch of the sounds in the generators. This seems a peculiar phenomenon. It does not last long, and it ends usually in a snapping and jumping over of sparks; then all is normal again.

With reference to the commercial utilization of ozone, Prof. Fahrig says: "Ozone is the strongest oxidizing agent known, and should be most useful particularly in bleaching processes. At present chloride of lime is used extensively as a bleacher. Chlorine, however, in a pure and dry state has no bleaching properties. But from its great affinity for hydrogen, forming oxygen and hydrochloric acid, chlorine becomes the strongest bleaching agent. It is the oxygen set free in the chlorine in combination with the water which performs the bleaching. Now ozone is nothing but oxygen in a condensed state. Oxygen converted into a 1, 2, or 3 per cent. ozone is a powerful bleacher. It is a mistaken idea that ozone can be produced at any per cent. of strength. Six and 7 per cent. of ozone is about the strongest one would care to handle, and a 1 per cent. of ozone is strong enough for almost any commercial oxidation. Ozone seems designed as nature's own oxidizing agent. By employing ozone instead of chlorine we substitute a harmless substance for a deadly poison. It would be a step forward did our spice merchants adopt ozone for bleaching ginger, pepper and all other food stuffs. It could be used also for treating drinking waters. Ozone alone can kill the bacteria in water. For instance, there is a splendid artesian well giving water with valuable medicinal properties, but on account of the water's passage at 1,800 ft. depth through coal and iron ores, it is highly impregnated with sulphureted hydrogen. There is no process so simple and inexpensive as treating such waters with ozone. Twenty grains of ozone per 1,000 gallons of water gives a good result. Here we have at once a large field for the use of ozone. Ozone could be used for bleaching paper, especially the better grades; also for treating sewage; for separating sugar in sugar refining; for preserving meat, fish, milk, etc.; for aging alcohol in general, and whisky in particular. By carefully handling whisky direct from the still we produced in 24 hours, with a six to one volume ozone pressed through at 7 inches U-tube pressure with a loss of 1·5 per cent., a liquor equal to that aged 10 years. The butyrine, amyline and toxy acids yield to ozone, whereas the most destructive distillation does not affect them. Whisky aged by ozone has been pronounced of first-class quality.

"Ozone is also used for making iodoform of very superior quality; for making aldehyde; for oxidizing heavy oils; for linoleum and oilcloth manufacture; for sterilizing water for brewing purposes and for general medicinal preparations and sanitary uses; for oxidizing aniline in course of manufacture; for solidifying H_2SO_4; for treating the sour mash in distilleries; for oxidizing animal products; bleaching wool, silk, ivory, bone, wax, tallow; bleaching sponges; treating eucalyptus and cod liver oil, citron and olive oils. A very brilliant experiment is the charging of certain liquids with ozone, which produces a phosphorescent light. This phenomenon has been observed by others besides myself, and Drs. Ring and Jeserich, of Berlin, attributed the light to the process of killing bacteria in the liquid. I cannot, however, entertain this theory. That ozone kills the bacilli is a fact, but the appearance of the phosphorescent light does not always prove that bacilli are present."

For the information and photographs relative to this interesting installation the *Western Electrician* is indebted to Prof. Fahrig and also to General Manager Gustave Monrath, Chicago. Mr. Monrath, it should be stated, acted as Prof. Fahrig's consulting electrical engineer in the construction of the Marseilles plant.—*Western Electrician.*

THE DONATO TOMMASI MULTITUBULAR ACCUMULATOR.

A CERTAIN number of reviews have for some time been publishing various articles upon a so-called new accumulator devised by Mr. Quaglia.

As regards this, permit me to observe that the said accumulator is nothing but a counterpart of the one that I invented and had patented as long ago as 1890, under the denomination of the "Donato Tommasi Multitubular Accumulator," and a description of which has been given in a large number of French and foreign scientific journals.

The following, in fact, is what may be read on this subject in the *Moniteur Industriel* of March 15, 1892:

"Each electrode of the Tommasi accumulator is com-

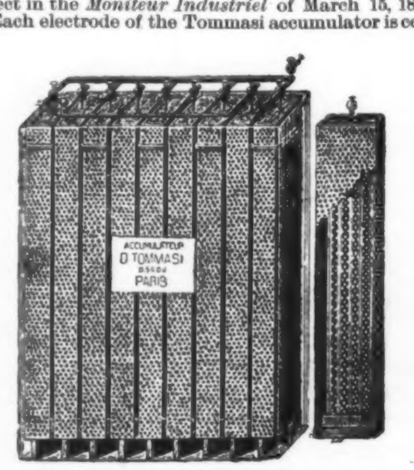


FIG. 1.

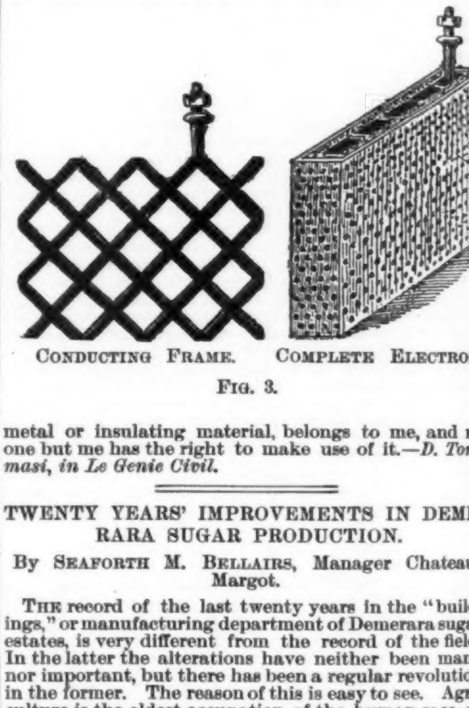
posed of a tube of hardened lead or of any insulating material (such as ebonite, celluloid, porcelain, etc.), closed by an insulating disk, and of a rod of hardened lead engaging with this disk and serving as a conductor. The tube may be cylindrical, square, or rectangular. The form of the conducting rod materially varies according to that of the cylinder. In the type with cylindrical and square electrodes, the conducting rod is of hardened lead and provided with a certain number of winglets. In the type with rectangular electrodes, the conductor consists of an assemblage of several wires spaced a few millimeters apart and arranged vertically in the form of a griddle. Finally, in the type with rectangular electrodes with elongated section (Fig. 2), it has the form shown in Fig. 3. The extremity of these conducting parts in type 1 is provided with terminals having, according to their diameter, an aperture in which engage by friction the pieces serving to unite the electrodes of the same name. At the upper part of the terminal there is a screw that serves to assure contact.

"In the type shown in Fig. 2 the terminals are replaced by a threaded rod provided with two nuts, against which the conducting plate is pressed. It is between this plate and the perforated tube that the

FIG. 2.

active material is placed. Special precautions are taken to prevent any contact or communication between the electrodes of different sign."

If, now, we examine the patent that I have taken out for the accumulator in question, we may be easily convinced that the tubular arrangement given to the electrodes with central core serves solely as a conductor and in nowise as a support of active materials, or what amounts to the same thing, the idea of covering the said electrodes with a perforated jacket, either of



CONDUCTING FRAME. COMPLETE ELECTRODE.

FIG. 3.

metal or insulating material, belongs to me, and no one but me has the right to make use of it.—*D. Tommasi, in Le Genie Civil.*

TWENTY YEARS' IMPROVEMENTS IN DEMERARA SUGAR PRODUCTION.

By SEAFORTH M. BELLAIRS, Manager Chateau Margot.

THE record of the last twenty years in the "buildings," or manufacturing department of Demerara sugar estates, is very different from the record of the field. In the latter the alterations have neither been many nor important, but there has been a regular revolution in the former. The reason of this is easy to see. Agriculture is the oldest occupation of the human race, so we cannot hope for much improvement in the comparatively short space of twenty years. But with regard to machinery we are still learning the very alphabet, and the progress of even a few years is absolutely startling.

To keep some sort of order, let us pay an imaginary visit to a sugar factory, and as we inspect each department we can consider what has been done in the last twenty years in the way of improvement.

We will begin at the beginning, which is the cane carrier. There has been much talk about improving the way in which the contents of the punts are to be placed on the carrier. It has been suggested that the punts could be raised bodily out of the water, either by a hydraulic ram or any other suitable means, and the contents shot out on to the carrier, by simply turning the punts upside down, but I do not think there has ever been any attempt to try the experiment, except perhaps with small models. The only improvement that I know of is the elongation of the carriers of the large mills, so that four punts can be discharged at the same time, whereby the throwers are not so crowded and there is not so much "keep back" when the punts are changed.

With regard to cane throwers, it is a singular thing that the number of men allowed for this work is nearly the same on every estate, though this similarity is quite accidental; nearly every estate employs a man for every ton of sugar made per day. Thus, an estate making 15 tons of sugar a day will have about 15 men throwing canes.

The next thing we come to is the cane engine and mill, and to describe the alterations attempted in this department, during the last twenty years, would take a whole *Timehri* to itself.

To begin with the engine. There used to be much dispute as to the relative fuel economy of condensing and "high pressure" engines. In old days it was not an uncommon sight to see an estate throw the whole of its "back pressure" steam into the air, and in such cases there could be no doubt that a condensing engine was the most economical. But we are much more

careful nowadays; the present price of sugar cannot afford such extravagance. We all know that steam is fuel, and fuel is money. It is now universally acknowledged that the higher the initial pressure, the greater is the economy, provided always that every atom of steam that passes from an engine is used for heating purposes.

However, the relative merits of different engines is not so much a sugar maker's question as an engineer's. So let us pass to the mill.

There are still very many mills at work in this colony that were working twenty years ago, but they do very different work. Crushing that would have been considered very creditable at that time would not be tolerated now, and many mills that are tolerated now are a constant grief to the sugar maker, and it is only the want of the capital necessary to put up a new crushing plant that keeps many a Demerara mill from the "scrap heap" in the yard.

A difference between 65 and 70 per cent. is one-thirteenth of the whole—that is, an estate making 1,300 tons of sugar a year, with a mill giving 65 per cent., would turn out 1,400 if the mill were made to give 70 per cent., and the extra hundred tons would be produced almost free of cost.

The first great stir and inquiry into the actual and possible work of our mills was when Mr. Russell first brought out "maceration;" everybody began to weigh canes and megass and see what his mill was doing, and try what it could be made to do. The first result was an alarming list of breakages—mill pinions, spur wheels and trash turners smashed in every direction; and one of the first great improvements in the mills was the almost universal adoption of steel gearing.

Then the head stocks proved to be the weak point. It was found that with indirect bolts no plate could stand the great strain. So head stocks with through-way bolts had to be imported.

The next trouble was the trash turners. Enormous bars of iron bent beneath the fearful strain. The whole principle of having trash turners at all was felt to be faulty; carrying huge quantities of megass across wide plates of iron under enormous pressure was obviously, to say the least of it, a great loss of force, especially as the motive power was the friction of the moving top roller.

Mills were brought out with moving trash turners, but I cannot say that they have proved the success that was anticipated. Mr. Allan showed a model of a mill with no trash turner at all. I believe that this mill has been erected on Plantation Albion, and is doing very good work, but I have not seen it nor any statistics of what it is doing.

Mr. Skekel also claims to have invented the mill of the future, and he explained this mill, which has come into practical existence at Plantation Herstelling, to the Royal Agricultural and Commercial Society.

I need not say very much about "maceration" and double crushing. Double crushing is a great improvement, but how far it pays to soak or macerate the megass, of course, depends on the relative values of sugar and fuel.

The original idea was to have one mill in front of the other, but the objection to this arrangement is that, in case of any accident to either, both are rendered useless, while if the mills are alongside of each other, each or either acts as a spare. The first carriers for conveying the megass from the one mill to the other were clumsy things, very much larger than necessary, Mr. Tilley was, I believe, the first to see that if the weight of the megass was less than half the weight of the canes, then the carrier of the megass need not be larger than half the size of the cane carrier. Moreover, by making the megass carrier travel at double the rate of the cane carrier, it need only be a quarter of its size and strength.

The difficulty of giving the second mill a constant, regular feed was met by arranging over it a shovel shaped like those used by bankers for shoveling gold. This is automatically waved to and fro by an ingenious eccentric so as to spread the megass in a layer of uniform depth on the moving lower roller of the second mill. As long as both engines are high pressure, and absolutely none of the exhaust steam is allowed to escape, the fuel required to drive the second mill is scarcely appreciable. So I think the double crushing, with or without maceration, may be set down as one of the greatest improvements effected during the last twenty years. No matter how good your first mill may be, be sure that a second will give such a further amount of juice from the seemingly exhausted megass as will be simply astonishing.

On looking back, one is amused by remembering the dismal prognostications as to the certain deterioration of the megass as fuel. It was taken as axiomatic that the more the canes were crushed the worse the result would be, as if it were the juice that burnt.

Experience has taught us the exact opposite. The drier the megass, the better it burns. "Can water burn?" was the answer of the late Mr. Russell to those who raised this argument against double crushing. As to the effect of maceration on the fuel, it, of course, entirely depends on the dryness of the megass when it leaves the second mill.

However, it does not do to talk of fuel while we are still at the mill; that subject should not be considered till we arrive at the boilers. We will suppose that the imaginary estate that we are visiting is trying to make the best possible sugar, yellow crystals for the London market. In that case the next thing we shall have to examine will be the sulphur box. Twenty years ago there were no sulphur boxes. The bleaching agent used was not free sulphurous acid, but bisulphite of lime, which did pretty well, but cost a lost of money.

The first sulphur boxes were awful machines; they reminded one of the corkscrew in the picture of Hogarth's—such an enormous apparatus and such very slight results. They were also getting constantly out of order, and estates had to keep a puncheon or two of bisulphite handy in case of need. This antique instrument—and there was a time when we gazed on it with pride—was like a gigantic churn, driven generally from a pulley on the cane engine, but the more "swagger" estates, I think, gave it an engine all to itself. There used to be a mania for giving things engines all to themselves. Each centrifugal used to have its own separate engine, and so did the pug mill, and many other things. And as all the exhaust steam was thrown away, the consumption of coal was very great, sometimes as much as twenty-four cwt. of coal to the ton of sugar produced, but what did that matter, with sugar at 30s. the cwt.?

To return to the sulphur box. The apparatus in present use is simplicity itself. It is simply a box made in any convenient shape. The juice enters at one end and is broken into spray; it falls like rain through the box and gets out at the other end; the fumes of burning sulphur enter at the bottom, and what is not absorbed by the juice exits at the top. The sulphur is burnt in a simple furnace, generally made out of an old condensed water trap, and is either blown into the box by a steam jet or a slight vacuum is created in the exit chimney by a jet, which makes the draught necessary to carry the fumes into the box.

The box is generally "sealed" so that air cannot enter at either end; this can be done by the simple expedient of turning up the ends of the pipes which carry the juice to and from the box. Thus the pipe is always full of fluid, and to prevent any acidity, a small drain hole is made in the bottom of the bend, to empty the pipes when the mill stops. This is somewhat difficult to explain in words, but a sketch would show the arrangement at a glance. It has been found that the sulphur does not all unite with the oxygen; in fact, there are two operations going on simultaneously; the one is combustion, and the other distillation. The consequence is that not only does the juice absorb some of the sulphurous acid, the result of the combustion, but it also condenses the boiling sulphur, precipitating "sublimed sulphur," which is deposited along with the subsidings of the clarifiers, and if allowed to get into the "wash," does immense damage to the quality and flavor of the rum.

It has been suggested that the best way to prevent this is to draw all the fumes of the burning sulphur through water, just like a hookah or coolie "hubble-bubble" pipe. But now that all the subsidings go to the filter presses, instead of the distillery, this is not of so much consequence, as the sulphur finds its way to the field, along with the filter press refuse. On the other hand some particles of sulphur, with a most distressing obstinacy, *will* take up one atom too much oxygen, thus converting themselves *into sulphuric* acid, instead of *sulphurous* acid as required; this goes into the box and starts a private factory of glucose, which shows itself very plainly in the large amount of molasses which comes away from the "masse cuite" in the centrifugals. To prevent this the fumes can be filtered through gas coke placed on perforated trays. Care must, however, be taken that the hot fumes do not ignite the coke, which would be attended with disadvantages.

The juice on leaving the sulphur box enters the "juice heater." There are some who prefer to sulphur hot, in which case the juice heater would come before the sulphur box; those in favor of sulphuring cold declare that there is much more inversion in the box when the juice is hot. The most serious argument in favor of sulphuring hot is that the juice heater avoids the corrosive effects of the sulphur gas, which attacks every metal and quickly eats them away.

I once imported a sulphur box made entirely of fire clay, and thought I had done a very clever thing and had solved the difficulty of corrosion; we started, and as soon as it got hot I heard "tink," "tink," and the whole apparatus splintered to atoms, so we had no opportunity of seeing whether that material would resist the corrosive effect of the gas. No metal can. Lead is the best, but that is so liable to melt that we have to be content with copper and constantly renew the metal part of the apparatus. The fumes have no effect on wood.

I do not think there has been any improvement in juice heaters during the last twenty years. They were, and are, too weak when the mill is grinding fast, and they did, and do, boil over when the flow of juice is smaller.

We now come to the clarifiers. There is no improvement in the clarifiers; in fact, it is here that the effects of extravagant economy are particularly noticeable. Twenty years ago most of the clarifiers had steam pipes in them. A few had the old-fashioned plan of fire under them. I remember one estate where there was a separate chimney to each clarifier, and a thin curl of megass smoke announced to the outside world when each clarifier was filled.

It is well known that there is one exact "cracking point," and it is distinctly advisable that the juice should be heated *up* to this point. The same perfect clarification is never obtained when the juice is cooled to that temperature. Therefore, the juice heater should always discharge the juice at a temperature slightly *below* the "cracking point." About 180° F. would be about the thing. Then it should receive the further heat in the clarifiers themselves. But the tubes, trunnions, etc., necessary to heat the clarifiers are dear, and they do not last forever, especially if subjected to the action of the omnivorous sulphur, so they have been discarded on most estates and the sugar maker has to do the best he can with the juice heater alone. One clarifier when full stands perhaps nearly boiling and the next possibly only 160° F. This may mean sugar that is not quite first class, or a loss of from 3d. to 1s. 6d. per cwt. on the whole crop.

It used to be believed that closed evaporators could not make as pretty sugar as was made by the old "copper wall." I believe that Mr. Duncan, at Plantation Hampton Court, was the first sugar maker who succeeded in turning out really first class sugar with a triple effect. And his success was entirely due to perfect clarification. This clarification was effected by heavy liming—in fact, any excess of lime mattered very little, unless extreme, for all the excess of lime was precipitated by the use of phosphoric acid in the shape of the insoluble salt, phosphate of lime. The use of this acid was impossible unless the evaporation was done at a low temperature, that is *in vacuo*, for if there be any free acid the great heat of "those disgusting frying pans," the teaches of the copper wall, would naturally cause inversion, and set up a huge molasses factory instead of sugar works. In addition to the better quality of sugar the users of phosphoric acid claim to recover a much larger percentage on the polariscope readings—in fact, some go so far as to assert that the recovery is equal to that obtained when refining, non-chemical, sugar is being made.

These assertions are very difficult to prove; sugar factories are scarcely adapted for very exact chemical experiments. There were (of course, there are none at present) planters who knew how to cook other things besides cane juice.

In the application of lime there have been many improvements during the last twenty years. The lime is no longer weighed; it is now mixed with water to a certain density (generally 10° Be., but some prefer 17° Be.); this is a smooth liquid "cream of lime." By this means the sugar maker can give a very exact dose of lime to each clarifier. The phosphoric acid is administered in exactly the same way.

If the estate is making refining sugar for the United States market, neither sulphur nor phosphoric acid will be used. This sugar is all refined into white sugar before it reaches the consumer. When making sugar for the English market it is most important to make a pretty sugar that will please the eye. It is a well known fact that wherever the houskeeping is done by the "fair sex," the producer has to think of the look of the thing, while wherever the sterner sex do the catering, it is the palate that has principally to be considered.

When the juice leaves the clarifiers it goes into the evaporators. These were, twenty years ago, the copper walls, so called in this colony on the "*lucus a non lucendo*" principle, for there was not an atom of copper about them. The copper wall had a twofold duty to perform; it evaporated the water and concentrated the juice to sirup or sugar, and also by skimming, the boiling fluid was cleansed. There are all sorts of objections to the old copper walls, but I think that, as regards the palate, "muscovado" sugar with its delicate pineapple flavor was, especially when new, the nicest sugar that has ever been made, and far preferable to the finest loaf, which has either no taste at all, except sweetness, or a distinctly nasty flavor. However, we have to make what the buyers want, and if the English public like a large-grained, bright yellow sugar, that is just what we must give them. If they wished it pea-green or sky-blue we should have to do the best we could to meet their wishes. Nowadays the copper walls are rapidly disappearing, and the present system is to send the juice to the eliminators, which the people in the building generally call "illuminators," where it is subjected to a brisk boil, and those impurities that have not subsided in the clarifiers now rise to the surface in the shape of scum and are removed. This, as a rule, finishes the cleaning process; the subsequent processes are chiefly evaporative. There are some who advocate filtering the juice after leaving the eliminators and before it enters the concentrators, but this is rarely, if ever, done.

Before visiting the evaporators let us see what has become of the subsidings and skimmings. Twenty years ago these would have gone into the coolers, and then have been sent to the distillery and turned into rum, and when rum was selling at a very good price, this was the best way of disposing of them. The buyer of rum does not want alcohol or any physicky stuff—he wants something nice to drink, and there can be no doubt that skimmings undoctored with chemicals does make a delightful spirit, delicately flavored with the distinctive aroma of the sugar cane, as any one who has ever visited Jamaica can testify—something very different from the coarse, fiery stuff which we turn out from the refuse of our sugar factories. John Girder in "The Bride of Lammermoor" says, "And if there is anything totally uneatable, let it be given to the puir folk." And we say, if there is anything that cannot possibly yield any sugar, send it to the distillery.

We subside our skimmings and then pass the refuse through the filter presses, and sometimes wash the cake by passing water through it so as to exhaust every possible particle of sugar. We reboil our molasses at least once, and are then surprised that our rum has not a good name.

We set up a mixture of dirt from the filter presses from which nearly every atom of sugar has been extracted, trench water and molasses, which has been heavily limed and reboiled so as to be as poor as it can possibly be. We are careful that this mixture shall stand at 1,060 S. G., and then we expect it to attenuate to 1,000 S. G., and to yield 8 per cent. of nearly absolute alcohol. As if we were able to *create* spirit.

All this care with the skimmings and molasses is undoubtedly a great improvement from the sugar point of view, and pays, unless sugar be selling very low and rum very high; but still it is absurd to eat our cake, in the shape of sugar, and expect to have it, too, in the form of rum.

Well, let us return from this short digression to the distillery to our evaporators.

The first *closed* evaporators in this colony are much older than twenty years; there is one at Chateau Margot, a vacuum pan, dated 1847.

The first multiple evaporator is, I believe, the triple effect at Vryheid's Lust, but I am not sure that the one at Enmore is not a little older. I do not think that either one is twenty years old yet. Sugar makers believe that the fine bright yellow color of the far-famed Demerara crystals was due to the scorching the juice received from the intense heat of the copper wall. They argued that the dull sugar made in closed evaporators fetched about 1s. 6d. per hundredweight below the best price, and this 1s. 6d. per hundredweight gained in the superior quality of the old-fashioned sugar more than covered the whole of the fuel account.

It is true that the percentage of recovery on the indicated sugar was less with one open preparation than with the cooler boiling in vacuo, but only a few knew what was indicated, and these comforted themselves by considering that what was lost in sugar was gained in rum.

I dare not enter into the relative merits of the various kinds of multiple effects; they are, all of them, improvements introduced during the last twenty years. Every one firmly believes in the apparatus that he is used to. We have all our own peculiar fancy, and our doxy is orthodoxy, and every one else's doxy is heterodoxy.

Any way, they are all much better than the old copper walls, and so may be classed among the improvements of the last twenty years.

We now come to the vacuum pan. There is no great improvement here. The machine is not now regarded with the same awe as it used to be. Twenty years ago the pan boiler was a sort of "boss conjurer." He alone knew all the secrets that were "into" the proof

stick. The old time planters knew very little of modern methods. I knew a proprietor, but I am glad to say not of British Guiana, who thought that litmus papers were some essays written by a Mr. Litmus on the subject of clarification. In the vacuum pans the sirup is boiled into masse cuite; this is "struck" into coolers, which were, twenty years ago, always very large. I am sure I do not know why, but they always were very large, and no one ever thought of making them otherwise. A half-naked laborer used to stand up to his middle in them and dig out their contents, with great expenditure of strength, etc. The etc. used to go, eventually, into the rum, I suppose.

Now, many estates have very small coolers—so small that they are called "sugar cans," from their resemblance to the tins containing salmon, etc. These cans hold about 500 pounds of masse cuite each, and they are very easily handled and transported. They are lifted up by a table rising on a hydraulic ram, they are turned upside down, and the contents fall into the pug mill. By this means the curing is much cleaner and quicker than it used to be, and the recovery is much higher, for it has been found that sugar goes on crystallizing while cooling after it leaves the pan, and the more rapid the cooling the greater the crystallization.

The curing is effected by Weston's centrifugals. Each one is able to dry a ton of sugar in two hours with the greatest ease. The dry sugar falls on to a traveler, which lands it into a trough, emptied by ascending scoops fastened to an endless belt, called a "Jacob's ladder," which carries it into the sugar store. How different to the process twenty years ago.

There were sugar diggers, masse cuite carriers and slow centrifugals, each with its attendant woman with her tray, which was filled by having the sugar *lifted* into it. Then she had to start, with a huge tray of sugar on her head, for quite a long walk, part of which would be up a steep flight of stairs. When I first came to this country I once asked a sugar curer boss why *women* were always employed for this work, and my English ears were startled by being informed, "Boss, you doesn't know that women's necks were made to carry weights."

When the sugar gets into the store it falls on to a sifter, which arrests any lumps. Twenty years ago it was tossed about by spades, and there was a ridiculous idea current the other side of the Atlantic that the lumps in the sugar were caused by the trampling of the bare feet of the laborers. I remember one estate that used to provide a sort of canvas boot for the feet of those employed in the sifting and filling of the sugar. I think that these boots were probably much dirtier than the feet that they covered; for after all those races do not cover their feet, the feet are no dirtier than our hands. And so there is quite as much dirt in a loaf of bread as ever there is in a ton of sugar.

The next step is the packing of the sugar. What an improvement is there here! Twenty years ago the sugar was packed in unsightly and unwieldy hogsheads, which for some occult reason were lined with blue paper, which was never seen by the consumer. Now the sugar goes in bags, all of which are filled to exactly the same weight. This department still has very much room for improvement, for, as far as looks go, there is very little to choose between the old-fashioned hogshead and the modern bag, but the bag is much handier, and moreover costs very much less.

Having made a hasty run through the sugar factory, let us return and see what becomes of the megass.

Twenty years ago it would have been received by a gang of "boxmen," who would have packed it in wheeled trucks and shoved it along an elevated level plane; it would have been dropped into the logies, there it would have been packed tight to remain till it got dry, when, if it had not been burned by spiteful laborers or carpenters out of work, it would have been carried on women's heads to the stoke hole and finally burned under the copper wall.

Now it is received on a carrier that hangs from one wheel, and this carrier is so light that one man can run about with it with the greatest ease: this tips the megass over a hole which leads to the grates of the boilers, and a man shoves the megass down to its last home.

Twenty years ago the megass was lifted breast high and shoved into a hole. The strongest man could not make fire for more than a few hours at a time, and then wringing wet and thoroughly exhausted, he had to be relieved; now one rarely sees a wet shirt. The army of boxmen shoving the trucks, and girls carrying the megass to the stoke hole, are no longer required; the estate saves about $2 a ton in wages, and if the factory is well arranged, and the juice fairly good, no other fuel than megass is required.

I said at the beginning of these papers that no regard should be paid to anything but dollars and cents, but here I must digress and point out the enormous improvement in the *comfort* of the present system of sugar making. Who that has ever had to keep a watch in the old-time buildings can ever forget that copper wall?—especially toward the end of the crop. The estate could not stop, the rains had begun, and the canes were beginning to take a "second spring;" besides there were reasons connected with the estate's finance and the rotation of the crop which compelled the manager reluctantly to go on with the sugar making. The dams are bad and the mules fagged out, the megass is only half dry, and it is a miserable work. To give an idea of the worst, let us imagine a Saturday night toward the end of December. The estate has been grinding for some months, the rain is falling heavily, and owing to the weather, and the dams being deep in mud, it is late before the number of clarifiers set as the day's task is filled.

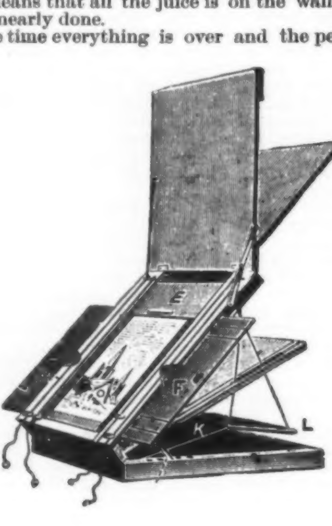
It is about 8 o'clock in the evening, and the mill has just stopped. The coppers on the wall are boiling heavily, the fuel is heavy and the flues are not clean. All the clarifiers are full, there is no room for sirup, and the pans have as much as they can do to convey all the thin sirup that is already in the subsiders into sugar before morning; therefore all the sirup that is now "sent up" must be boiled sweet, as it will have to keep until Monday morning. The manager looks in about 9, and says that all the sirup must be boiled to a density of at least 18° Be., he gives a general look around, bids "good night," which sounds bitter irony, and goes to his bed.

It is some time before the flooded wall begins to get sweet or any sirup to be sent up. Then there is a cry from the stoke hole, and the overseer goes to see what is the matter, and finds that there is not an atom of megass. This means a walk through the pouring rain to the logie, and a grand routing up of the megass carriers, who, poor things, have been hard at work for about eighteen hours already. The driver wakes up from a half nap, and pretends to flog them all around with a piece of long megass. She wonders why they have been so long at their "dinner," and says that they are "real table people," the table consisting of a saucepan, or calabash, and a spoon.

Presently the head boiler informs you that the liquor is only simmering, as the fuel is so damp, and he says that if you "don't look sharp," you will have the liquor as red as blood. This means another trip to the logie, and there is a grand search to see if there is any dry fuel to be scraped from the outside of any of the pens. The procession of girls is seen in the dim light, they walk as close as they can to the building of the logie to avoid the mud, and the water from the eaves pours into their baskets; the distance is very considerable, and the megass, damp when it started, becomes positively wet before it reaches its destination. Something must be done. The head boiler suggests "patent fuel." Alas, there is none. A search in the trench may bring forth a lump or two that has accidentally fallen from the punts that brought the last lot to the factory, but that does not last long. Another suggestion is to mix in a few lumps of coal. This is tried and seems to be doing well, but it is soon discovered that it is clogging the grating bars. Meantime the density of the sirup scarcely rises at all, and now and then the end positively "goes down," *i. e.*, boils flat like water instead of in a foam like milk.

Then there will be a slight pause in the rain and the megass will be a trifle better. Then down comes another shower. Still, everything comes to an end in time. When the weary night has almost gone and the twittering of the birds announces the approaching dawn, the welcome sound is heard, "Take water," which means that all the juice is on the wall and the work is nearly done.

By the time everything is over and the people are



THE PHOTOGRAPHOSCOPE.

paid, it is broad daylight, and the weary overseer goes to his bed at about 6 o'clock in the morning with the unpleasant consciousness that there are two boxes which only stand 18 deg. Baume. This will mean explanations which will probably be received with a grunt and the words, "Well, don't let it happen again."

At breakfast the manager will ask at what time the fire was hauled, and will say, "I am glad it was before the train passed up in the morning; it does not look well to be seen smoking on a Sunday."

If this is unpleasant for the overseer who only occasionally has to take the watch, what must it be for the laborers, who take every watch? Every morning at three they had to turn out and work till generally ten o'clock at night, or even later.

Compare this with the modern system on a well regulated sugar estate. If the buildings "go through," there are double gangs, if not, everything stops within a few minutes of the cane mill. Even on Saturdays, the factory is closed about nine, and everything is turned, not into sirup as in the old time, but into *masse cuite*. The megass is green, and therefore it is always the same, and therefore the fuel is of one constant quality and does not differ from day to day. The work is not nearly so hard; in fact, in the modern buildings, the only gang that has hard work to do is the cane-throwing gang. They have each to throw about 15 tons of canes breast high. There is no difficulty in manning such buildings. The overseer has not to tramp around the houses every morning to turn the people out.

I can remember when the buidings overseer had to make out a list of those men who had been told off to man the factory, and to give copies to each of the other overseers, so that if they did not go to the factory they got no other employment, even if they did not receive a summons to attend the magistrate's court.

Another great advantage in the modern system is removing of the everlasting anxiety about fire. The natural end of a logie, as of a theater, was to be burnt. And to make matters worse, these fires were generally incendiary, so much so that they were always declared to have been done on purpose, and this caused much bad feeling between the employers and the employed.

In this sketch I have said nothing about diffusion, first, because the subject is so important that it deserves an essay all to itself, and, secondly, because I know so little of it. I hope, however, that such a paper will be written by some one who does know all about it.

I have said very little about the distillery, but this is far too big a question to be satisfactorily treated at the end of an article.—*La. Planter.*

THE PHOTOGRAPHOSCOPE.

ONE of the novelties which attracted attention at the Edinburgh convention was the "photographoscope," a Continental invention sold by Messrs. Houghton & Son, London. It consists in the first place of a frame opening out not unlike a retouching desk, this frame being arranged to support the picture in a suitable position in front of reflectors. To use it, unmounted photographs are taken, and the skies cut away, the photograph then being rendered transparent by a suitable medium, which is supplied. The transparent photograph is then placed upon the glass front of the instrument, while behind it in a suitable position is a sheet of artificial clouds, which are tinted blue, and by the use of a series of colored pieces of cardboard of various tints, the light from which is reflected through the picture, a variety of pleasing effects such as night, sunset, sunrise, and so on may be obtained, while the effect may be further enhanced, if desired, by tinting the photograph itself. As an instrument for drawing room entertainment and a pleasing variety from the everlasting album of views, the "photographoscope" certainly commends itself.—*Photography.*

SULPHATE OF LIME AS A LOADING MATERIAL.

CRYSTALLIZED sulphate of lime, $CaSO_4+2H_2O$, is sold under different names in the market and has been used for very many years by paper makers as a loading material. The various kinds, although substantially similar in chemical composition, yet differ from one another in physical properties and in the effects they produce. Although it is a good loading for specific purposes, owing to certain properties, common to all the commercial sorts, its consumption in the paper industry is not very extensive. It is in the first place more costly weight for weight than China clay, its great rival, and owing to the fact that it is somewhat soluble in water, the use of the finer qualities would cost more than China clay, even were they to be purchased as cheaply. Certain kinds of this are prepared artificially in the wet way by chemical methods, while others are prepared from the mineral found native in England and elsewhere.

Pearl and Crystal Hardening.—These are essentially the purest and finest forms of the loading. When dry they correspond in composition to pure sulphate of lime, $CaSO_4 2H_2O$, thus:

Dry sulphate of lime	= 79·07	per cent.
Water of crystallization	= 20·93	"
	100·00	

Pearl hardening differs very little, if indeed at all, from the crystal hardening. If any difference exists it lies in the relative amounts of moisture which they contain, and in some instance on the relative degrees of fineness. They may be prepared in a fine state of division by adding a solution of salt cake or sulphate of soda, from which the iron and sedimentary matter has been removed with soda or lime and subsequent settling, to a clear neutral solution of chloride of calcium. The waste calcium liquor from the Weldon's manganese recovery process is used for this purpose. The white precipitate formed by adding these liquors together is allowed to deposit, the clear superincumbent brine liquor drawn off, and the pearl hardening washed and then partially dried in a hydro-extractor. As it occurs on the market, it is a soft pure white substance, somewhat plastic or soapy to the touch, free from grit or large crystals, and contains about 13 per cent. of hygroscopic water in addition to the water of crystallization corresponding to the amount of dry $CaSO_4$ it contains in accordance with the above formula.

Pearl hardening imparts to the paper a greater degree of whiteness than China clay, but it does not "bulk" so well. The difference in this respect, although appreciable, is small. It has a tendency to stiffen the paper, and papers loaded with it glaze and print well, being closely allied to those loaded with China clay. Owing to its opacity, great whiteness, etc., it is used for the finest kinds of writing papers. Its action in absorbing colors is similar to China clay.

Terra Alba.—Gypsum or native sulphate of lime is found in very extensive deposits in England, of greater or less purity. The rock from which terra alba is prepared is colorless and almost free from other impurities; it is in fact almost pure $CaSO_4 + 2H_2O$. This crystalline rock ground to an impalpable powder is the terra alba of commerce, and is usually perfectly free from moisture. It therefore contains a greater percentage of dry sulphate of lime than pearl or crystal hardening, and yields proportionately better; but, as it is specifically heavier and not in so fine a state of division, it imparts somewhat different characteristics to paper which is loaded with it. Terra alba does not absorb colors, owing to its hard crystalline nature, and therefore it is used with advantage in colored papers. It does not possess the whitening properties of the other kinds.

In Germany an anhydrous sulphate of lime is sold to paper makers as a loading under the name of *Annaline*. Hoffman gives the composition of this substance as follows:

Dry sulphate of lime	97·63	per cent.
Lime	0·75	"
Magnesia	0·71	"
Ferric oxide and alumina	—	"
Insoluble matter	trace	"
Water	0·84	"
	99.93	

The loading is prepared by simply heating native crystalline sulphate of lime to expel the water of crystallization, and then grinding it to an impalpable powder. In this state it is synonymous in composition

with "plaster of Paris," and like this when moistened it takes up 26 per cent. of its weight of water and is reconverted into hydrated sulphate of lime. This being so, when annaline is added to pulp in the beater engine it absorbs water, thereby increasing in weight, and in consequence yields well.

As these different forms of sulphate of lime are all soluble to a certain extent in water, the water in the beater engine and that used on the wire dissolves very appreciable quantities of them. The ease with which they dissolve varies somewhat, the artificially prepared pearl hardening passing into solution more readily than the native terra alba. This is due to a slight difference in their physical condition. To minimize this tendency to dissolve, the pearl hardening, etc., is usually mixed with 10 per cent. or so of its weight of starch, and the mixture boiled to form a thick paste. In this state the solubility is diminished, and consequently the yield obtained as a mineral residue in the finished paper is proportionately increased. The extent to which the solubility takes place may be inferred from the following figures. It has been found that water dissolves 0·224 per cent. of its weight of anhydrous sulphate of lime, or 0·271 per cent. of the crystalline salt $CaSO_4 + 2H_2O$. The amount of water associated with the pulp in a beater engine is about 100 parts for every 7 parts of dry paper, or say 1,430 lb. per 100 lb. of paper. These 1,430 parts of water dissolve $14·30 \times 0·271 = 3·87$ parts of $CaSO_4 + 2 H_2O$, but as the pulp from the beater engine is diluted with a further addition of water in the stuff chest, and again by more water as it leaves the regulation box, the amount actually dissolved is obviously much greater than is represented by 3·87 parts. The amount of dilution very much depends on the arrangements of the paper machine and on the thickness of the paper made; and the comparatively poor yield in mineral residue when working pearl hardening is attributable to this.

Varrentrap and Kuchln found that by the addition of 18 per cent. of annaline (anhydrous sulphate of lime) to the pulp only 1¼ per cent. came out in the finished paper as residue, giving a yield of 7 per cent. (nearly) reckoned on the quantity of loading added. When, however, 33 per cent. of annaline previously boiled in water with 18 per cent. of its weight of starch was used, the amount of mineral residue obtained on the sheet was 14 to 15 per cent., equal to an average yield of 44 per cent. reckoned on the total weight of loading. The first result is very low, and it is possible to conceive conditions under which this could happen, such, for example, as the use of soft water in the engine and of "back water" not saturated with sulphate of lime. On the other hand, the comparatively high yield of the second trial is not altogether due to the fact that the annaline was previously boiled with starch, but also to the fact that a comparatively greater proportion was used to the paper made. If the quantity of water used to make the respective papers were the same, it must follow that $18 - 1·25 = 16·75$ lb. annaline were dissolved in the first trial, and this amount must also have been dissolved in the second. If, therefore, we deduct 16·75 from 33, we get 16·25, which nearly corresponds to the 14-15 per cent. mineral matter found in the paper. Owing, then, to the solubility of pearl hardening, etc., it is obvious that as the volume of water used in the beater engine and on the paper machine is nearly constant for similar classes of paper, the less mineral matter required, the greater is the proportionate loss; or, the more sulphate of lime required in the paper, the greater will the proportionate yield be on the weight of sulphate used.

In comparing the relative yields of these different forms of loading it is instructive to do so under equal conditions. Pearl hardening contains only 66 per cent. of dry sulphate of lime, while annaline contains 98 per cent., and terra alba 78 per cent. If we make an allowance in calculating the results on trials of these substances, for the amount of water, free and combined, which they contain, a comparison of the percentage yield reveals the fact that the amount of sulphate of lime ($CaSO_4$) dissolved by the water is substantially the same in all cases and that any difference as a loading between one form of sulphate of lime and another is due to difference in original composition rather than to any other condition.

As hydrated sulphate of lime does not lose its water of crystallization on continued heating at 212° F., this loading retains the water, when the paper is dried in the ordinary way on the drying cylinders of the paper machine; but, when the mineral residue is estimated by incineration, the whole of the water is driven off. The amount of residue obtained in this way does not truly represent the crystallized sulphate of lime in the sample of paper. An allowance of 26 per cent. of the weight of the dry residue must be made, in order to arrive at the correct percentage of loading due to the presence of hydrated sulphate of lime. It is well known that China clay possesses the same property of retaining water of hydration on drying at 212° F., but in its case the allowance is much smaller; in fact, only about one half the above amount, viz., 13 per cent. This fact ought not to be overlooked when pearl hardening and China clay are compared as loading substances.—*Chem. Tr. Jour.*

THE CONSTRUCTION OF A SUN DIAL.

In order to construct a simple sun dial, take a piece of Bristol board about the size of a playing card, and, with a penknife, make an incision so as to obtain two planes, A and B (Fig. 2), united as if by a hinge. Applying the point of a pair of compasses in their line of intersection, trace, in the horizontal plane, a double arc of a circle, which cut out and leave attached to the card at the point, *a*. A slit, *b*, made in the plane, B, at the same distance from the edge as the line, *a*, will serve to allow it to pass through this plane. In the center of the latter, draw a straight line at right angles with the hinge or joint, and along this line glue a piece of cardboard, C. Finally, a fourth piece, D, provided with a slit and glued to the posterior edge of the plane, B, will serve to keep the piece, C, at right angles with the latter. Divide the small arc into degrees. If the cardboard, C, has been oriented in the meridian, and the plane, B, fixed upon a division giving the complement of the latitude of the place, this plane will be parallel to the equator, and the anterior edge, *c*, of the cardboard, C, will be parallel to the axis of the world. Our sun dial will then be finished. Before gluing the three pieces of which it is constructed, care must be taken to draw upon the plane, B, a circumference around the point that is to be occupied by the base of C, and to divide it into sectors of 15°. To this effect, apply a leg of the compasses upon a line at right angles with the intersection of the planes, A and B, and lay off a radius on each side, and then divide the arcs thus obtained twice into two parts. It remains to place our instrument in the meridian. To this effect we may use a watch, and, so to speak, set our sun dial; but we shall doubtless prefer that it shall be indebted to no one. Into the board upon which it is proposed to place it, stick a strong pin vertically,

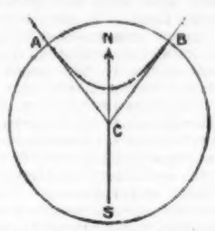


FIG. 1.—DIAGRAM OF ORIENTATION OF SUN DIAL.

and then mark from hour to hour the shadow of its head. Unite the points thus obtained by a curve, and, after removing the pin, draw a circumference around the point that it occupied. Join the center, C (Fig. 1), with the points of intersection, A B, and it will then suffice to bisect the angle, A, B, C, to obtain the meridian in the S N direction. Apply the edge of the plane, A, against the line, S N, and fix it by two pins placed in such a way that they shall keep the plane, B, at the inclination indicated by the arc of a circle.

The instrument presents one inconvenience: If it happens to rain without the precaution having been taken to cover it, it will be immediately ruined; but and cork. Fix the glass with cement to a board, F, that will be traversed by the needle. We shall thus obtain the instrument shown in Fig. 3, which it will then suffice to set as we did the first.

If some of our young readers possess a little skill they may easily construct a sun dial that is in wide use among the shepherds of the Landes and Pyrenees, who manufacture it themselves. A sort of skittle with movable head (Fig. 4) carries upon its circumference the name of the months and various curves corresponding to the hours of the day. A small sheet of tin is held by a nail traversing the head. If, the sheet being placed at the date of the day, the instrument be so suspended that the shadow of this style falls vertically upon the cylinder, its extremity will mark the hour thereon. The form of the horary curves may be calculated. It appears to us more probable that the instrument is graduated by copying from another or by direct observation.—*La Nature.*

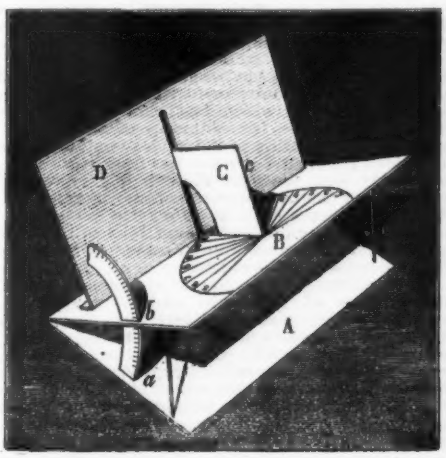


FIG. 2.—SUN DIAL MADE OF BRISTOL BOARD.

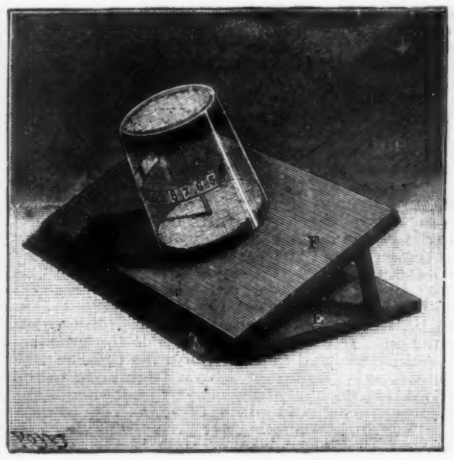


FIG. 3.—SUN DIAL MADE OF A TUMBLER.

we can construct one without any more trouble that will not be injured by storms. The horary angles of the first are inscribed upon a plane, but we can draw them upon a cylinder without their ceasing to be shown by equidistant lines. Take a tumbler (Fig. 3) or a piece of lamp chimney if there are means at disposal to trim and grind the fractured edge. In this case the extremities must be closed with corks; or else there may be fixed to the bottom of the glass a piece of thick cardboard having a small aperture in the center that may be closed with a cork. But, before this, fix in the interior of the glass a band of paper, *b*, upon which the hours have been marked.

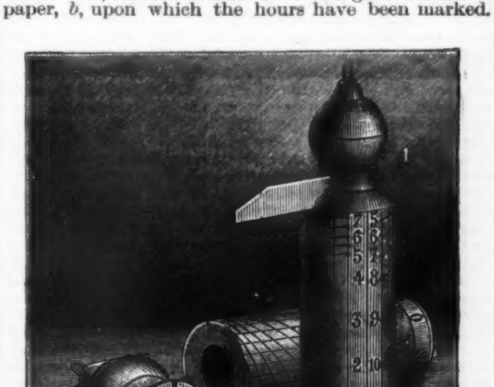


FIG. 4.—SUN DIAL OF THE SHEPHERDS OF THE PYRENEES.

For this, it will suffice to cut out the band in such a manner that it shall make one entire revolution in the interior of the glass, to divide it into twenty-four equal parts, numbered twice from 1 to 12, and to cut the ends from 0 to 5 and from 7 to 12. Then fix a knitting needle, *c*, in the axis of the glass by passing it through small apertures made in advance in the cardboard

[Continued from SUPPLEMENT, No. 872, page 13939.]

THEORY OF THE EARTH.

By Sir ARCHIBALD GEIKIE.

THE ICE AGE.

As the most recent and best known of these great transformations, the ice age stands out conspicuously before us. If any one sixty years ago had ventured to affirm that at no very distant date the snows and glaciers of the Arctic regions stretched southward into France, he would have been treated as a mere visionary theorist. Many of the facts to which he would have appealed in support of his statement were already well known, but they had received various other interpretations. By some observers, notably by Hutton's friend, Sir James Hall, they were believed to be due to violent debacles of water that swept over the face of the land. By others they were attributed to the strong tides and currents of the sea when the land stood at a lower level. The uniformitarian school of Lyell had no difficulty in elevating or depressing land to any required extent. Indeed, when we consider how averse these philosophers were to admit any kind or degree of natural operation other than those of which there was some human experience, we may well wonder at the boldness with which, on sometimes the slenderest evidence, they made land and sea change places, on the one hand submerging mountain ranges and on the other placing great barriers of land where a deep ocean rolls. They took such liberties with geography because only well established processes of change were invoked in the operations. Knowing that during the passage of an earthquake a territory bordering the sea may be upraised or sunk a few feet, they drew the sweeping inference that any amount of upheaval or depression of any part of the earth's surface might be claimed in explanation of geological problems. The progress of inquiry, while it has somewhat curtailed this geographical license, has now made known in great detail the strange story of the Ice Age. There cannot be any doubt that, after man had become a denizen of the earth, a great physical change came over the northern hemisphere. The climate, which had previously been so mild that evergreen trees flourished within ten or twelve degrees of the North Pole, now became so severe that vast sheets of snow and ice covered the north of Europe and crept southward beyond the south coast of Ireland, almost as far as the southern shores of England, and across the Baltic into France and Germany. This Arctic transformation was not an episode that lasted merely a few seasons and left the land to resume thereafter its ancient aspect. With various successive fluctuations it must have endured for many thousands of years. When it began to disappear it probably faded away as slowly and imperceptibly as it had advanced, and when it finally vanished it left Europe and North America profoundly changed in the character alike of their scenery and of their inhabitants. The rugged rocky contours of earlier times were ground smooth and polished by the march of the ice across them, while the lower grounds were buried under wide and thick sheets of clay, gravel, and sand, left behind by the melting ice. The varied and abundant flora which has spread so far within the Arctic circle was driven away into more southern and less ungenial climes. But most memorable of all was the extirpation of the prominent large animals which, before the advent of the ice, had roamed over Europe. The lions, hyenas, wild horses, hippopotami, and other creatures either became entirely extinct or were driven into the Mediterranean basin or into Africa. In their place came northern forms—the reindeer, glutton, musk ox, woolly rhinoceros and mammoth. Such a marvelous transformation in climate, in scenery, in vegetation and in

inhabitants, within what was after all but a brief portion of geological time, though it may have involved no sudden or violent convulsion, is surely entitled to rank as a catastrophe in the history of the globe. It was probably brought about mainly, if not entirely, by the operation of forces external to the earth. No similar calamity having befallen the continents within the time during which man has been recording his experience, the Ice Age might be cited as a contradiction to the doctrine of uniformity. And yet it manifestly arrived as part of the established order of Nature. Whether or not we grant that other ice ages preceded the last great one, we must admit that the conditions under which it arose, so far as we know them, might conceivably have occurred before, and may occur again. The various agencies called into play by the extensive refrigeration of the northern hemisphere were not different from those with which we are familiar. Snow fell and glaciers crept as they do to-day. Ice scored and polished rocks exactly as it still does among the Alps and in Norway. There was nothing abnormal in the phenomena save the scale on which they were manifested. And thus, taking a broad view of the whole subject, we recognize the catastrophe, while at the same time we see in its progress the operation of those same natural processes which we know to be integral parts of the machinery whereby the surface of the earth is continually transformed.

THE AGE OF THE EARTH.

Among the debts which science owes to the Huttonian school, not the least memorable is the promulgation of the first well founded conceptions of the high antiquity of the globe. Some six thousand years had previously been believed to comprise the whole life of the planet, and indeed of the entire universe. When the curtain was then first raised that had veiled the history of the earth, and men, looking beyond the brief span within which they had supposed that history to have been transacted, beheld the records of a long vista of ages stretching far away into a dim illimitable past, the prospect vividly impressed their imagination. Astronomy had made known the immeasurable fields of space; the new science of geology seemed now to reveal boundless distances of time. The more the terrestrial chronicles were studied, the farther could the eye range into an antiquity so vast as to defy all attempts to measure or define it. The progress of research continually furnished additional evidence of the enormous duration of the ages that preceded the coming of man, while as knowledge increased, periods that were thought to have followed each other consecutively were found to have been separated by prolonged intervals of time. Thus the idea arose and gained universal acceptance that, just as no boundary could be set to the astronomer in his free range through space, so the whole of bygone eternity lay open to the requirements of the geologist. Playfair, re-echoing and expanding Hutton's language, had declared that neither among the records of the earth nor in the planetary motions can any trace be discovered of the beginning or of the end of the present order of things; that no symptom of infancy or of old age has been allowed to appear on the face of Nature, nor any sign by which either the past or the future duration of the universe can be estimated; and that although the Creator may put an end, as he no doubt gave a beginning, to the present system, such a catastrophe will not be brought about by any of the laws now existing, and is not indicated by anything which we perceive. This doctrine was naturally espoused with warmth by the extreme uniformitarian school, which required an unlimited duration of time for the accomplishment of such slow and quiet cycles of change as they conceived to be alone recognizable in the records of the earth's past history.

KELVIN AND TAIT.

It was Lord Kelvin who, in the writings to which I have already referred, first called attention to the fundamentally erroneous nature of these conceptions. He pointed out that from the high internal temperature of our globe, increasing inward as it does, and from the rate of loss of its heat, a limit may be fixed to the planet's antiquity. He showed that so far from there being no sign of a beginning and no prospect of an end to the present economy, every lineament of the solar system bears witness to a gradual dissipation of energy from some definite starting point. No very precise data were then, or indeed are now, available for computing the interval which has elapsed since that remote commencement, but he estimated that the surface of the globe could not have consolidated less than twenty millions of years ago, for the rate of increase of temperature inward would in that case have been higher than it actually is; nor more than four hundred millions of years ago, for then there would have been no sensible increase at all. He was inclined when first dealing with the subject to believe that, from a review of all the evidence then available, some such period as one hundred millions of years would embrace the whole geological history of the globe. It is not a pleasant experience to discover that a fortune which one has unconcernedly believed to be ample has somehow taken to itself wings and disappeared. When the geologist was suddenly awakened by the energetic warning of the physicist, who assured him that he had enormously overdrawn his account with past time, it was but natural under the circumstances that he should think the accountant to be mistaken, who thus returned to him dishonored the large drafts he had made on eternity. He saw how wide were the limits of time deducible from physical considerations, how vague the data from which they had been calculated. And though he could not help admitting that a limit must be fixed beyond which his chronology could not be extended, he consoled himself with the reflection that after all a hundred millions of years was a tolerably ample period of time, and might possibly have been quite sufficient for the transaction of all the prolonged sequence of events recorded in the crust of the earth. He was therefore disposed to acquiesce in the limitation thus imposed upon geological history. But physical inquiry continued to be pushed forward with regard to the early history and the antiquity of the earth. Further consideration of the influence of tidal friction in retarding the earth's rotation, and of the sun's rate of cooling, led to sweeping reductions of the time allowable for the evolution of the planet. The geologist found himself in the plight of Lear when his bodyguard of one hundred knights was cut down. "What need you five-and-twenty, ten, or five?" demands the inexorable physicist, as he remorselessly strikes slice after slice from his allowance of geological time. Lord Kelvin is willing, I believe, to grant us some twenty millions of years, but Prof. Tait would have us content with less than ten millions. In scientific as in other mundane questions there may often be two sides, and the truth may ultimately be found not to lie wholly with either. I frankly confess that the demands of the early geologists for an unlimited series of ages were extravagant, and even for their own purposes unnecessary, and that the physicist did good service in reducing them. It may also be freely admitted that the latest conclusions from physical considerations of the extent of geological time require that the interpretation given to the record of the rocks should be rigorously revised, with the view of ascertaining how far that interpretation may be capable of modification or amendment. But we must also remember that the geological record constitutes a voluminous body of evidence regarding the world's history which cannot be ignored, and must be explained in accordance with ascertained natural laws. If the conclusions derived from the most careful story of this record cannot be reconciled with those drawn from physical considerations, it is surely not too much to ask that the latter should be also revised. It has been well said that the mathematical mill is an admirable piece of machinery, but that the value of what it yields depends upon the quality of what is put into it. That there must be some flaw in the physical argument I can, for my own part, hardly doubt, though I do not pretend to be able to say where it is to be found. Some assumption, it seems to me, has been made, or some consideration has been left out of sight, which will eventually be seen to vitiate the conclusions, and which when duly taken into account will allow time enough for any reasonable interpretation of the geological record.

THE UNIVERSAL DEGRADATION OF THE LAND.

In problems of this nature, where geological data capable of numerical statement are so needful, it is hardly possible to obtain trustworthy computations of time. We can only measure the rate of changes in progress now, and infer from these changes the length of time required for the completion of results achieved by the same processes in the past. There is fortunately one great cycle of movement which admits of careful investigation, and which has been made to furnish valuable materials for estimates of this kind. The universal degradation of the land, so notable a characteristic of the earth's surface, has been regarded as an extremely slow process. Though it goes on without ceasing, yet from century to century it seems to leave hardly any perceptible trace on the landscapes of a country. Mountains and plains, hills and valleys, appear to wear the same familiar aspect which is indicated in the oldest pages of history.

This obvious slowness in one of the most important departments of geological activity doubtless contributed in large measure to form and foster a vague belief in the vastness of the antiquity required for the evolution of the earth. But, as geologists eventually came to perceive, the rate of degradation of the land is capable of actual measurement. The amount of material worn away from the surface of any drainage basin and carried, in the form of mud, sand, or gravel, by the main river into the sea, represents the extent to which that surface has been lowered by waste in any given period of time. But denudation and deposition must be equivalent to each other. As much material must be laid down in sedimentary accumulations as has been mechanically removed, so that in measuring the annual bulk of sediment borne into the sea by a river, we obtain a clew not only to the rate of denudation of the land, but also to the rate at which the deposition of new sedimentary formations takes place. As might be expected, the activities involved in the lowering of the surface of the land are not everywhere equally energetic. They are naturally more vigorous where the rainfall is heavy, where the daily range of temperature is large, and where frosts are severe. Hence they are obviously much more effective in mountainous regions than on plains; and their results must constantly vary, not only in different basins of drainage, but even, and sometimes widely, within the same basin. Actual measurement of the proportion of sediment in river water shows that while in some cases the lowering of the surface of the land may be as much as $\frac{1}{730}$ ft. in a year, in others it falls as low as $\frac{1}{6800}$ ft. In other words, the rate of deposition of new sedimentary formations over an area of sea floor equivalent to that which has yielded the sediment may vary from 1 ft. in 730 years to 1 ft. in 6,800 years. If now we take these results and apply them as measures of the length of time required for the deposition of the various sedimentary masses that form the outer part of the earth's crust, we obtain some indication of the duration of geological history. On a reasonable computation these stratified masses, where most fully developed, attain a united thickness of not less than 10,000 ft. If they were all laid down at the most rapid recorded rate of denudation, they would require a period of seventy-three million years for their completion. If they were laid down at the slowest rate, they would demand a period of not less than 680 millions. But it may be argued that all kinds of terrestrial energy are growing feeble, that the most active denudation now in progress is much less vigorous than that of bygone ages, and hence that the stratified part of the earth's crust may have been put together in a much briefer space of time than modern events might lead us to suppose.

Such arguments are easily adduced and look sufficiently specious, but no confirmation of them can be gathered from the rocks. On the contrary, no one can thoughtfully study the various systems of stratified formations without being impressed by the fullness of their evidence that, on the whole, the accumulation of sediment has been extremely slow. Again and again we encounter groups of strata composed of thin paper-like laminæ of the finest silt, which evidently settled down quietly and at intervals on the sea bottom. We find successive layers covered with ripple marks and sun cracks, and we recognize in them memorials of ancient shores where sand and mud tranquilly gathered as they do in sheltered estuaries at the present day. We can see no proof whatever, nor even any evidence, which suggests that, on the whole, the rate of waste and sedimentation was more rapid during Mesozoic and Paleozoic time than it is to-day. Had there been any marked difference in this rate from ancient to modern times, it would be incredible that no clear proof of it should have been recorded in the crust of the earth. But in actual fact the testimony in favor of the slow accumulation and high antiquity of the geological record is much stronger than might be inferred from the mere thickness of the stratified formations. These sedimentary deposits have not been laid down in one unbroken sequence, but have had their continuity interrupted again and again by upheaval and depression. So fragmentary are they in some regions that we can easily demonstrate the length of time represented there by still existing sedimentary strata to be vastly less than the time indicated by the gaps in the series.

THE EVIDENCE OF SUCCESSIVE RACES OF PLANTS AND ANIMALS.

There is yet a further and impressive body of evidence furnished by the successive races of plants and animals which have lived upon the earth and have left their remains sealed up within its rocky crust. No one now believes in the exploded doctrine that successive creations and universal destructions of organic life are chronicled in the stratified rocks. It is everywhere admitted that, from the remotest times up to the present day, there has been an onward march of development, type succeeding type in one long continuous progression. As to the rate of this evolution precise data are wanting. There is, however, the important negative argument furnished by the absence of evidence of recognizable specific variations of organic forms since man began to observe and record. We know that within human experience a few species have become extinct, but there is no conclusive proof that a single new species has come into existence, nor are appreciable variations readily apparent in forms that live in a wild state. The seeds and plants found with Egyptian mummies, and the flowers and fruits depicted on Egyptian tombs, are easily identified with the vegetation of modern Egypt. The embalmed bodies of animals found in that country show no sensible divergence from the structure or proportions of the same animals at the present day. The human races of Northern Africa and Western Asia were already as distinct when portrayed by the ancient Egyptian artists as they are now, and they do not seem to have undergone any perceptible change since then. Thus a lapse of four or five thousand years has not been accompanied by any recognizable variation in such forms of plant and animal life as can be tendered in evidence. Absence of sensible change in these instances is, of course, no proof that considerable alteration may not have been accomplished in other forms more exposed to vicissitudes of climate and other external influences. But it furnishes at least a presumption in favor of the extremely tardy progress of organic variation. If, however, we extend our vision beyond the narrow range of human history, and look at the remains of the plants and animals preserved in those younger formations which, though recent when regarded as parts of the whole geological record, must be many thousands of years older than the very oldest of human monuments, we encounter the most impressive proofs of the persistence of specific forms. Shells which lived in our seas before the coming of the Ice Age present the very same peculiarities of form, structure, and ornament which their descendants still possess. The lapse of so enormous an interval of time has not sufficed seriously to modify them. So, too, with the plants and the higher animals which still survive. Some forms have become extinct, but few or none which remain display any transitional gradations into new species. We must admit that such transitions have occurred, that indeed they have been in progress ever since organized existence began upon our planet, and are doubtless taking place now. But we cannot detect them on the way, and we feel constrained to believe that their march must be excessively slow. There is no reason to think that the rate of organic evolution has ever seriously varied; at least, no proof has been adduced of such variation. Taken in connection with the testimony of the sedimentary rocks, the inferences deducible from fossils entirely bear out the opinion that the building up of the stratified crust of the earth has been extremely gradual. If the many thousands of years which have elapsed since the Ice Age have produced no appreciable modification of surviving plants and animals, how vast a period must have been required for that marvelous scheme of organic development which is chronicled in the rocks! After careful reflection on the subject, I affirm that the geological record furnishes a mass of evidence which no arguments drawn from other departments of Nature can explain away and which, it seems to me, cannot be satisfactorily interpreted save with an allowance of time much beyond the narrow limits which recent physical speculation would concede.

THE LAW OF EVOLUTION.

I have reserved for final consideration a branch of the history of the earth which, while it has become, within the lifetime of the present generation, one of the most interesting and fascinating departments of geological inquiry, owed its first impulse to the far-seeing intellects of Hutton and Playfair. With the penetration of genius these illustrious teachers perceived that if the broad masses of land and the great chains of mountains owe their origin to stupendous movements which from time to time have convulsed the earth, their details of contour must be mainly due to the eroding power of running water. They recognized that as the surface of the land is continually worn down, it is essentially by a process of sculpture that the physiognomy of every country has been developed, valleys being hollowed out and hills left standing, and that these inequalities in topographical detail are only varying and local accidents in the progress of the one great process of the degradation of the land. From the broad and guiding outlines of theory thus sketched we have now advanced amid ever-widening multiplicity of detail into a fuller and nobler conception of the origin of scenery. The law of evolution is written as legibly on

the landscapes of the earth as on any other page of the book of nature. Not only do we recognize that the existing topography of the continents, instead of being primeval in origin, has gradually been developed after many precedent mutations, but we are enabled to trace these earlier revolutions in the structure of every hill and glen. Each mountain chain is thus found to be a memorial of many successive stages in geographical evolution. Within certain limits, land and sea have changed places again and again. Volcanoes have broken out and have become extinct in many countries long before the advent of man. Whole tribes of plants and animals have meanwhile come and gone, and in leaving their remains behind them as monuments at once of the slow development of organic types, and of the prolonged vicissitudes of the terrestrial surface, have furnished materials for a chronological arrangement of the earth's topographical features. Nor is it only from the organisms of former epochs that broad generalizations may be drawn regarding revolutions in geography. The living plants and animals of to-day have been discovered to be eloquent of ancient geographical features that have long since vanished. In their distribution they tell us that climates have changed, that islands have been disjoined from continents, that oceans once united have been divided from each other, or once separate have now been joined; that some tracts of land have disappeared, while others for prolonged periods of time have remained in isolation. The present and the past are thus linked together, not merely by dead matter, but by the world of living things, into one vast system of continuous progression. In this marvelous increase of knowledge regarding the transformations of the earth's surface, one of the most impressive features, to my mind, is the power now given to us of perceiving the many striking contrasts between the present and former aspects of topography and scenery. We seem to be endowed with a new sense. What is seen by the bodily eye—mountain, valley, or plain—serves but as a veil, beyond which, as we raise it, visions of long-lost lands and seas rise before us in a far-retreating vista. Pictures of the most diverse and opposite character are beheld, as it were, through each other, their lineaments subtilely interwoven, and even their most vivid contrasts subdued into one blended harmony. Like the "poet we see, but not by sight alone;" and the "ray of fancy" which, as a sunbeam, lightened up his landscape is for us broadened and brightened by that play of the imagination which science can so vividly excite and prolong. Admirable illustrations of this modern interpretation of scenery are supplied by the district wherein we are now assembled. On every side of us rise the most convincing proofs of the reality and potency of that ceaseless sculpture by which the elements of landscape have been carved into their present shapes. Turn where we may, our eyes rest on hills that project above the lowland, not because they have been upheaved into these positions, but because their stubborn materials have enabled them better to withstand the degradation which has worn down the softer strata into the plains around them. Inch by inch the surface of the land has been lowered, and each hard rock successively laid bare has communicated its own characteristics of form and color to the scenery.

A GEOLOGICAL RETROSPECT.

If, standing on the Castle Rock, the central and oldest site in Edinburgh, we allow the bodily eye to wander over the fair landscape, and the mental vision to range through the long vista of earlier landscapes which science here reveals to us, what a strange series of pictures passes before our gaze! The busy streets of to-day seem to fade away into the mingled copsewood and forest of prehistoric time. Lakes that have long since vanished gleam through the woodlands and a rude canoe pushed from the shore startles the red deer that has come to drink. While we look, the picture changes to a Polar scene, with bushes of stunted Arctic willow and birch, among which herds of reindeer browse and the huge mammoth makes his home. Thick sheets of snow are draped all over the hills around, and far to the northwest the distant gleam of glaciers and snow fields marks the line of the Highland mountains. As we muse on this strange contrast of the living world of to-day the scene appears to be more Arctic in aspect, until every hill is buried under one vast sheet of ice, 2,000 ft. or more in thickness, which fills up the whole midland valley of Scotland and creeps slowly eastward into the basin of the North Sea. Here the curtain drops upon our moving pageant, for in the geological record of this part of the country an enormous gap occurs before the coming of the ice age. When once more the spectacle resumes its movement the scene is found to have utterly changed. The familiar hills and valleys of the Lothians have disappeared. Dense jungles of a strange vegetation—tall reeds, club mosses, and tree ferns—spread over the steaming swamp that stretches for leagues in all directions. Broad lagoons and open seas are dotted with little volcanic cones which throw out their streams of lava and showers of ashes. Beyond these, in dimmer outline, and older in date, we descry a wide lake or inland sea, covering the whole midland valley, and marked with long lines of active volcanoes, some of them several thousand feet in height. And still further and fainter over the same region, we may catch a glimpse of that still earlier expanse of sea which in Silurian times overspread most of Britain. But beyond this scene our vision fails. We have reached the limit across which no geological evidence exists to lead the imagination into the primeval darkness beyond.

THE BIRD ON ITS NEST.

By MORRIS GIBBS.

ALTHOUGH many interesting points in relation to the nesting habits of our friends, the birds, have appeared, I have yet to see anything concerning the position which the prospective parent assumes while incubating. The subject has been of much interest to me, and in the past years many observations have been made, which plainly indicate that the proprietors of nearly all nests "have their exits and their entrances." Many there are, as the kingfishers, woodpeckers, and other species, which reach their eggs by a single opening or burrow, and these of necessity must emerge from the same source; but all seem to have a well defined position in sitting, as we shall see.

All can remember the attitude of the domestic hen, turkey, or goose, and how rarely this position is changed; and with the wild bird the tendency to a shift is even less, for with barnyard fowls we can alter their posture by placing a board in a variety of positions about the nest, but with the inhabitants of the wood any interference generally results in desertion. The robin when building her nest often tries how her brooding breast is to fit the growing structure, and this, too, when a bare, flat platform gives no indication of the elevated sides to follow. Later, the male sits in the forming cup, and speculates, probably, on the outcome of his efforts, and views the outlook from the crotch. During the four days of egg laying the female is not on, or rather in, the structure to any extent, unless the weather is cold or wet, and she assumes almost any position. It is only after the duties of incubation begin, a period which lasts fourteen days to a dot, that the robins adopt a standard, shared in by each of the pair. The male who shares in the duties of sitting, when going to take his trick, almost invariably flies toward his mate in the same path, and arriving at the back door, just as his feet are about to touch the edge, the female is seen to dart forward between the branches which comprise the front door. This front door, as I prefer to call it, is then really the exit, and toward it the incubating bird always points her bill. It never directs toward the tree trunk, and generally points toward an open space in the foliage when in a thick-leaved tree or bush.

With all birds, so far as I am able to learn, the exit is a point of observation for the sitter, from which it can get a view of friends and foes. The owls and hawks from an elevated position can command a fine view of the surroundings. With all aquatic birds the sitter almost invariably occupies a position presenting toward the water. Shore birds, as the sandpipers, rest on their nests in a position to best view the stream or pond. Rails and gallinules face the water, the latter usually building so that they can plunge from their homes directly into their favorite channels. The loon, who builds, or rather forms, its nest away out from shore in a mass of vegetable matter, usually the foundation of an old muskrat's house, invariably faces the open, deep water. From that position it can slide into the lake at a second's notice. Any one can prove this position of the loon by examining the premises when the owner is away. The nest proper is merely a trough-like depression, evidently formed by the bird's efforts at hollowing, rather than in building up the sides. This oblong depression is a foot and a half long and over ten inches wide, and the eggs are always placed from three-fifths to two-thirds of the distance from the front end.

In a large number of nests of the brown pelican, which I examined on an island in Indian River, Florida, all gave evidence that the old birds sat in one position, usually with the front to the water. It was interesting to note that, although the very young birds, which occupied many of the nests, assumed no regular position, the larger young nearly all presented toward the shore.

In the case of ruffed grouse and quail, the position occupied while on the nest is invariably that which gives the best view of the surroundings from the more or less concealed retreat. Who ever heard of a grouse's nest where the old bird faced into the brush pile or toward the stump or log?

The arboreal sparrows, vireos, and many other smaller birds usually sit upon nests built on horizontal limbs, with the head from the trunk, and when the nest is much elevated the position is usually chosen so that the sitter will face the prevailing wind. Birds will nearly always, when on or off the nest, face the wind; and, if observations are taken, nearly all birds on the nest will be found in one position if a strong wind is blowing.—*Science.*

THE TRUE BASIS OF ANTHROPOLOGY.*

THE Nestor of American philologists, and at the same time the indefatigable Ulysses of comparative philology in that country, Mr. Horatio Hale, has just published, in the Transactions of the Royal Society of Canada, an important essay on "Language as a Test of Mental Capacity," being an attempt to demonstrate the true basis of anthropology. His first important contribution to the science of language dates back as far as 1838-42, when he acted as ethnographer to the United States exploring expedition, and published the results of his observations in a valuable and now very scarce volume, "Ethnography and Philology." He has since left the United States and settled in Canada. All his contributions to American ethnology and philology have been distinguished by their originality, accuracy, and trustworthiness. Every one of them marks a substantial addition to our knowledge, and, in spite of the hackneyed disapproval with which reviewers receive reprints of essays published in periodicals, it is much to be regretted that his essays have never been published in a collected form.

Mr. Horatio Hale's object in the essay before us is to show that language separates man from all other animals by a line as distinct as that which separates a tree from a stone, or a stone from a star.

"A treatise," he writes, "which should undertake to show how inanimate matter became a plant or an animal would, of course, possess great interest for biologists, but it would not be accepted by them as a treatise on biology. In like manner a work displaying the anatomy of man in comparison with that of other animals cannot but be of great value, and a treatise showing how the human frame was probably developed from that of a lower animal must be of extreme interest; but these would be works, not of anthropology, but of physiology or biology. Anthropology begins where mere brute life gives way to something widely different and indefinitely higher. It begins with that endowment which characterizes man, and distinguishes him from all other creatures. The real basis of the science of anthropology is found in articulate speech, with all that it indicates and embodies." He does not hesitate to maintain that solely by their languages can the tribes of men be scientifically classified, their affiliations discovered, and their mental qualities discerned. These premises, he says, compel us to the logical conclusion that linguistic anthropology is the only "Science of Man."

These words explain at once the whole character of this important essay. Mr. Horatio Hale is a great admirer of Darwin, but not of the Darwinians. He contrasts Darwin's discernment of the value of language with the blindness of his followers, who are physiologists and nothing else. Why anthropology has of late been swamped by physiology, Mr. Horatio Hale explains by the fact that the pursuit of the latter science is so infinitely the easier. "To measure human bodies and human bones, to compute the comparative number of blue eyes and black eyes in any community, to determine whether the section of a human hair is circular, or oval, or oblong, to study and compare the habits of various tribes of man, as we would study and compare the habits of beavers and bees, these are tasks which are comparatively simple. But the patient toil and protracted mental exertion required to penetrate into the mysteries of a strange language, and to acquire a knowledge profound enough to afford the means of determining the intellectual endowments of the people who speak it, are such as very few men of science have been willing to undergo." Mr. Horatio Hale has a right to speak with authority on this point, for, besides having studied the several languages of North America, of Australia, and Polynesia, no one has more carefully measured skulls, registered eyes, measured hair, and collected antiquities and curiosities of all kinds than he has done during his long and busy life. His knowledge of the customs of uncivilized races is very considerable. No one knows the Indian tribes and likewise the Australians better than he does, and he is in consequence very severe on mere theorizers who imagine they have proved how the primitive hordes of human beings, after herding together like cattle, emerged slowly through wife-capture, mother-right, father-right, endogamy, exogamy, totemism, fetichism, and clan systems, to what may be called a social status. He holds with Darwin that man was from the beginning a pairing animal, and that the peculiar usages of barbarous tribes are simply the efforts of men, pressed down by hard conditions below the natural stage, to keep themselves from sinking lower. He gives a most graphic description of changes of civilization produced by change of surroundings in the case of the savage Athapascans, and their descendants, the quick-witted and inventive Navajos. He holds that the inhabitants of Australia were originally Dravidians, and that their social and linguistic deterioration is due to the miserable character of the island in which they had taken refuge, possibly from the Aryans, when pressing upon the aboriginal inhabitants of the Dekhan. He points out a few grammatical terminations in the Dravidian languages which show some similarity to the terminations of Australian dialects. The dative, for instance, is formed in the Dravidian Tulu by *ku*, and in the Lake Macquarie and Wiradhurei dialects of Australia by *ko*. In both families the *k* of *ku* and *ko* is liable to be changed into *g*. The plural suffix in Tamil is *gal*, in Wiradhurei, *galan*. Thus in Tamil *maram*, tree, forms the nom. plur. *marangal*, the dat. plur. *marangaluk-ku*; while in Wiradhurei, *bagai*, shell, appears in the nom. plur. as *bagaigalan*, in the dat. plur. as *bagaigalan-gu*. On this point, however, Mr. Horatio Hale ought to produce fuller evidence, particularly from numerals, and the common household words of uncivilized tribes. The pronouns show many coincidences with Dravidian and Australian languages. No one is better qualified for that task than he is, for we really owe to him the first trustworthy information about the Australian dialects. He considers all the dialects spoken in Australia as varieties of one original speech, and he has proved their wonderful structure by several specimens contained in his first book, published nearly fifty years ago, and again in this last essay of his.

There is no doubt that this essay will provoke much opposition, but no one can read it without deriving most valuable information from it, and without being impressed with the singularly clear and unbiased judgment of the author. It is to be hoped that if there is any controversy it may be carried on in the same scientific and thoroughly gentlemanlike tone in which Mr. Horatio Hale deals with those whom he has to reprove. Thus, when Prof. Whitney, a fertile writer on linguistic science in America, commits himself to the statement that the Dravidian languages have "a general agglutinative structure *with prefixes only*," Mr. Horatio Hale good naturedly remarks, "This is doubtless a misprint for *with suffixes only*." And when Prof. Gerland, in his continuation of Waitz's invaluable work "Die Anthropologie der Naturvolker," refers to Mr. Horatio Hale as describing the hair of the Australians as *long, fine, and woolly*, he points out that he, on the contrary, described their hair as neither woolly, like that of the Africans and Melanesians; nor frizzled, like that of the Feejeeans; nor coarse, stiff, and curling, as with the Malays; but as long, fine, and *wavy*, like that of Europeans. He naturally protests against Prof. Friedrich Muller charging him with having committed such a blunder, which, as he remarks, would be as bad as if he had described the Eskimos as having black skins. But there is not a single offensive expression in the whole of his essay, though the opportunities would have been many for adopting the style of hitting indiscriminately above and below the belt. Though he differs from Prof. Whitney, he evidently ranks him very high, and as second only to "that eminent Sanskrit scholar, Sir Monier Monier-Williams."—*Nature.*

* "Language as a Test of Mental Capacity." By Horatio Hale. From the Transactions of the Royal Society of Canada, 1891.

BLACK MOSS.

TWENTY years ago that valuable article of commerce, black moss, was but little known north of the boundary of the States to which it belonged, but now nearly every child in America is familiar with the appearance of that gray, trailing parasite, and one has only to call upon his imagination to picture the lovely scene which this moss presents as it gracefully swings in deep festoons from the sturdy limbs of the giant live oak or gnarled branches of the cypress.

The artist has reproduced upon canvas the likeness of some tranquil lake, the bosom of whose dark waters forms a mirror to reflect the deep arches of the verdant dome which shelter it from the fierce rays of the burning sun, and whose drooping curtains are so matted and interwoven as to almost exclude the faint-

est breath from heaven which could tend to ruffle the surface of the lagoon and break the solemn silence of the landscape.

He has gone farther, he has shown the sluggish alligator lying motionless upon the bank apparently oblivious to all surroundings. The painter has depicted the copperhead and deadly moccasin coiled up, asleep, on their beds of decaying vegetation, uncombative now, but only waiting for the disturbance of some venturesome intruder to dart forth their venom and lay low the audacious mortal who dares to approach too near their sylvan domain.

But it is not the reptile that taxes most the skill of the artist as he endeavors to reproduce the scene; it is the long, sinuous tendrils of the gossamer-like garment which enfolds, and well nigh completely hides, the naked trunks and branches of the giants of the forest.

Although the moss hangs heavily from the trees, it, unlike other parasitical growths, saps little of the strength and vigor of its support, but seems to live and thrive on the miasma-impregnated atmosphere of the torrid swamp. It is not of the beauty alone of Florida moss with which this article deals, but of its value to manufacturers throughout the civilized world, the manner in which it is gathered and the way it is prepared for the market.

Of course, its use is confined principally to the upholstering and mattress-making trades, although it is utilized by the carriage trimmer, the trunk packer, the florist and decorator; and tons upon tons are annually secured to supply the demand.

As in the case of the production of nearly every other commodity, the poor Southern peasant, or "cracker," as he is best known, who gathers and "cures" the moss, is the worst paid. To be sure the finer qualities of the article retail in New England cities for 6½ and 7½ cents per pound, but when the wholesale dealer and broker have deducted their commissions, and the transportation charges have been met, the gatherer, who spends most of his time in the unhealthy swamps, finds himself far from rich after his season's labor, and is content if he receives even one dollar per hundredweight.

The live moss is ashen gray in color, soft and almost silky to the touch. This peculiar quality is due to the bark which closely incases the hair-like stem, and this covering must be removed before the article is of any value to the manufacturer.

Some years ago the mattress maker and upholsterer essayed to use the moss in its crude state; but it did not prove a success, for it soon matted down into a hard mass, and the article which it had filled became unsightly and worthless.

When, however, it is thoroughly cured, and all of its velvety coat removed, the fiber is strong and "lively," having a "spring" to it which is unequaled by any other filling, with the exception, of course, of hair.

Although the article is generally known as Florida moss, yet the finer grades come from Louisiana. Not that the vegetable production is better in its original state, but it is more carefully "cured," and this process is exceedingly simple.

The gatherers select a swamp, and, plunging into its gloomy depths, first choose a spot as clear as may be from cypress and palmetto roots, and also free from water; but the soil must be rich and alluvial.

Here an excavation some two feet deep, and, perhaps, twenty feet square, is made. This is the pit to receive the fresh moss as soon as it is collected.

When the hole is filled the whole is covered with a layer of damp, black earth, from six to eight inches thick; then the hunters remove their camp to another spot, leaving the mass behind them to rot.

Unlike most vegetable matter, the moss does not decay, only the bark yields to the combined influence of heat, moisture and time.

Six months are generally required to properly free the wiry stems of their perishable coverings, after which the most arduous portion of the labor begins, to transfer the moss from the swamp to some sandy place, where it can receive the full force of the rays of the torrid sun, that it may become thoroughly dried.

Children and women are now called upon to turn it and toss it up lightly, so that it may be benefited by a circulation of air as well as heat.

A week is a sufficient period to properly "cure" a mass of twenty tons, which is, indeed, a formidable looking bulk before it is pressed into bales for shipping.

In most places old fashioned hand gear is used in packing, but in Louisiana many hydraulic presses are utilized, which are capable of crowding at least 500 pounds into a bale of convenient size. As before stated, the moss dispatched from New Orleans brings a higher price in the market, because the "curers" allow it to remain longer in the pit to decompose and give it more time to dry afterward.

The people employed in that section of the country are, as a class, more intelligent and harder workers, and will gather none but live moss, while the "cracker" of Florida too frequently contents himself with the dead article, which has fallen from the trees of its own weight, and rotted upon the surface of the ground. This is sorely matted, and besides contains much foreign matter such as bark, twigs, and often bones of animals and reptiles that have found a burial place beneath the same covering which had protected them in life from the fierce heat of the noonday sun.

In their indolence the people will not devote the time and labor requisite to thoroughly cleanse the moss, and consequently many a lot finds its way to market so filled with accumulated trash as to be almost worthless.

It is a well known fact to the practical worker that this "dead" moss lacks strength and "spring," and no matter how carefully it may be "picked up" will soon "break down," and thus spoil an otherwise good piece of furniture.

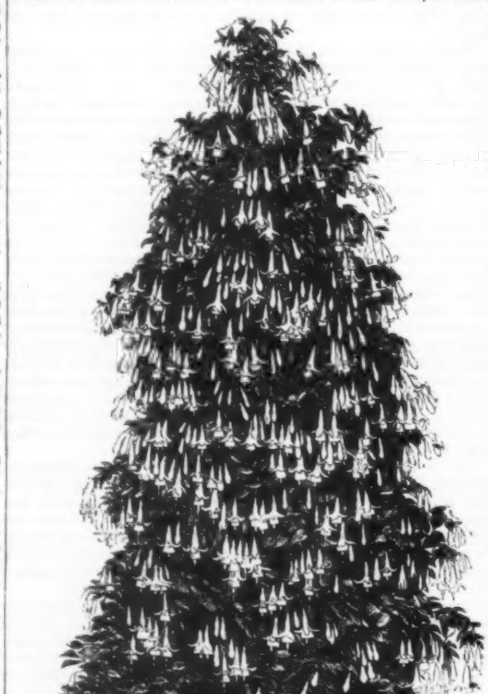
Since Florida has become such a fruit-growing State the uncured moss is in considerable demand for packing, and is in every way equal to paper, while it is not nearly as expensive.

The winter tourists to the Land of Flowers are wrapped in admiration of the rich beauty of the long, gray tendrils which brush their cheeks as they stroll beneath the branches of the trees, and when they return to their northern homes make requisitions upon their florists to procure some of this same moss with which to decorate their homes, until now some shippers from Florida find it more to their advantage to select handsome sprays of "green" moss for ornamental purposes, instead of handling the "cured" material alone, for the gain in the former case is more than ten times as great.

In conversation with a prominent dealer of this city, the writer learned that at the present time excelsior and Western flax were, to some extent, superseding the moss in the cheapest kinds of upholstered work; but for the ordinary grades the product of the Florida and Louisiana swamps was the only article which could be used to advantage and with profit to the manufacturer; consequently, Florida moss is destined to remain a staple article in the market for years to come.—*Com. Bulletin.*

FUCHSIAS.

IN the absence of Mr. Fry, his interesting paper on this subject was read by Rev. W. Wilks before the Royal Horticultural Society. The essayist commenced his paper with an interesting historical sketch of the fuchsia, which was first introduced to this country about 1746, from Chile, by a sailor. The plant was exhibited in the window of his mother's house, and while there attracted considerable attention from an individual who communicated the fact to Mr. Lee, a nurseryman at Hammersmith, who, after much trouble, succeeded in obtaining the novelty for 80 guineas, which was afterward called, but improperly, F. coccinea. In 1830 the first English hybrid was raised, and from that year (and especially after 1840) new hybrids were frequently distributed.



SPECIMEN FUCHSIA (ARABELLA).

In 1885 the first varieties with white corollas were distributed by Henderson, but how they were obtained must ever remain a mystery, as the raiser (Mr. Storrey, of Newton Abbot) died about the time his plants were being distributed, without leaving any particulars respecting them. Mr. Fry then went on to describe the beautiful specimens that were grown as early as 1843, some of which were under his charge, and were about 14 feet high. He thought that the unpopularity of the fuchsia at the present time was partly due to the very different style of horticultural buildings which obtain now, and in which it was extremely difficult to find room for large specimen plants. But the lecturer dwelt upon the fact that room might and ought to be afforded for dwarf plants, which can be raised and brought to perfection in about six or eight months.

Mr. Fry said that although some of the best varieties had been obtained solely by bee fertilization, if advances were to be made and certain peculiarities to be developed, it was imperative that they should be fertilized by the cultivator, and all other chance of pollination be guarded against. The seed, which should be thoroughly matured, should be carefully taken from the pulp and dried, so that they may be stored away until about February, when they may be sown thinly in shallow pans or boxes (which should be well perforated), and carefully labeled as to pedigree, etc. Cover them very thinly with fine mould, and place some sheets of glass over them, covering the whole with tissue. They will appear in about fourteen to twenty-one days, when the glass and paper should be taken off.

When they are large enough to handle they are pricked off into pots, and when about an inch high are put singly into small pots, using very light soil. As soon as they are nicely rooted they are shifted into three inch pots, and placed on a shelf in the greenhouse. They should then be moved on as they require, and will commence to bloom when they are five or six months old. Mr. Fry had always longed to raise a perfectly white fuchsia, and had failed; but he had been greatly pleased that Mr. Cocker, of Aberdeen, had been more successful, and had raised Countess of Aberdeen, which was admirable in all respects. Although its growth was rather weak, it could be grown into specimen plants under proper treatment, and included in this was the requisite amount of shading.

Propagation.—As soon as the shoots were of sufficient length they should be taken off and put into a compost of loam, leaf soil, and sand; or they would strike easily, and more quickly, if put into cocoanut fiber. When struck, they should be potted singly into small pots, and afterward into four inch, and larger as they may require. The best soil was the top spit from meadow land, with some sharp silver sand, to which, if the loam be heavy, a little fibrous peat ought to be added. When potting into the larger pots, Mr. Fry advised a little soot and dry cow manure to be added. The compost was to be moist, but not wet, at the time of using, and the plants were to have a thorough watering before potting, and they would then be best if not watered until two or three days after the operation. A high temperature was disastrous to fuchsias, and the lecturer recommended a temperature of from 50° to 75° as being most conducive to success.

Mr. Fry then spoke of the adaptability of the fuchsia as a bedding plant, and of the pretty effect produced by planting those with white corollas on a groundwork of lobelia, and the colored ones on a bed of mesembryanthemums; concluding by appealing to compilers of schedules to give more encouragement to the growth and exhibition of this floral gem.

THE PEST OF FIELD MICE IN THESSALY AND LOEFFLER'S SUCCESSFUL METHOD OF COMBATING IT.*

By MEADE BOLTON.

THE valley of Thessaly was recently threatened with entire destruction of its growing crops by swarms of field mice, which had suddenly appeared in such alarming numbers that the farmers and the government were at their wits' ends to discover efficient means to combat the pest. Several different poisons were tried at public expense, and it was also attempted to drown the mice out in some places; but, owing to the difficulties of application and the inefficiency of these methods, it was found greatly desirable to look for other means.

Pasteur was applied to by one of the large landowners for cultures of some microbe which could be used to destroy the mice, and Pasteur promptly referred his correspondent to Loeffler in Greifswald, who had discovered a bacillus which would answer the purpose. Pasteur's answer was sent to the government at Athens, and as the attention of the government had already been called to Loeffler's work by the Grecian ambassador at Berlin, Loeffler was requested to send cultures to be used in the infested districts. Fearing that the tests would not be made in such a manner as to secure success, Loeffler informed the Grecian ambassador that, although he was willing to give the cultures, he would prefer to make the experiment himself, provided his expenses were paid.

On April 1 Loeffler received notice that if he would come the Grecian government was willing to pay his expenses and those of an assistant. So, after being informed that the mice were of the kind † that he had found susceptible to infection with his bacillus, Loeffler and his assistant, Dr. Abel, set out with a supply of cultures on April 5 from Berlin, and arrived in Athens April 9.

On going to the pathological laboratory, he was shown some of the mice from Thessaly, and to his chagrin he found they differed from the kind he had worked on at home. Fortunately, however, it was found that the mice at Athens were even more susceptible to inoculation and also to infection through the alimentary canal than those in Germany. This fact was established in a few days by inoculating and feeding the mice in the laboratory with cultures of the organism.

Preparations for experiment on a large scale were at once made, and Loeffler, Dr. Abel, and Dr. Pampoukis, director of the bacteriological laboratory in Athens, set sail on April 16 for Volo, and went by rail from thence to Larissa, the capital of Thessaly.

Loeffler had found that the micro-organism, Bacillus typhi murium,‡ grows very well in a decoction of oat and barley straw to which one per cent. of peptone and one-half per cent. of grape sugar have been added. So a large amount of this liquid was prepared and inoculated. Pieces of bread about the size of a finger were soaked in these cultures after abundant growth was secured, and the bread was then distributed in the openings of the burrows of the mice. A number of mice were also inoculated and turned loose; this was done because the mice eat the bodies of those that die and spread contagion in this way. It had been amply proved by experiment that the bread soaked in the culture could be eaten by man and various domestic animals with perfect impunity.

In a few days after the holes had been baited, news came from all sides that the infected bread had disappeared from the holes. This news was very satisfactory, as it could by no means be certainly counted upon beforehand that the mice would eat the bread, surrounded as they were with abundance of fresh food. A visit to Bakrena, about nine days after the experi-

* Centralblatt fur Bacteriologie und Parasitenkunde, Bd. xii., No. 1.

† Arvicola arvalis.

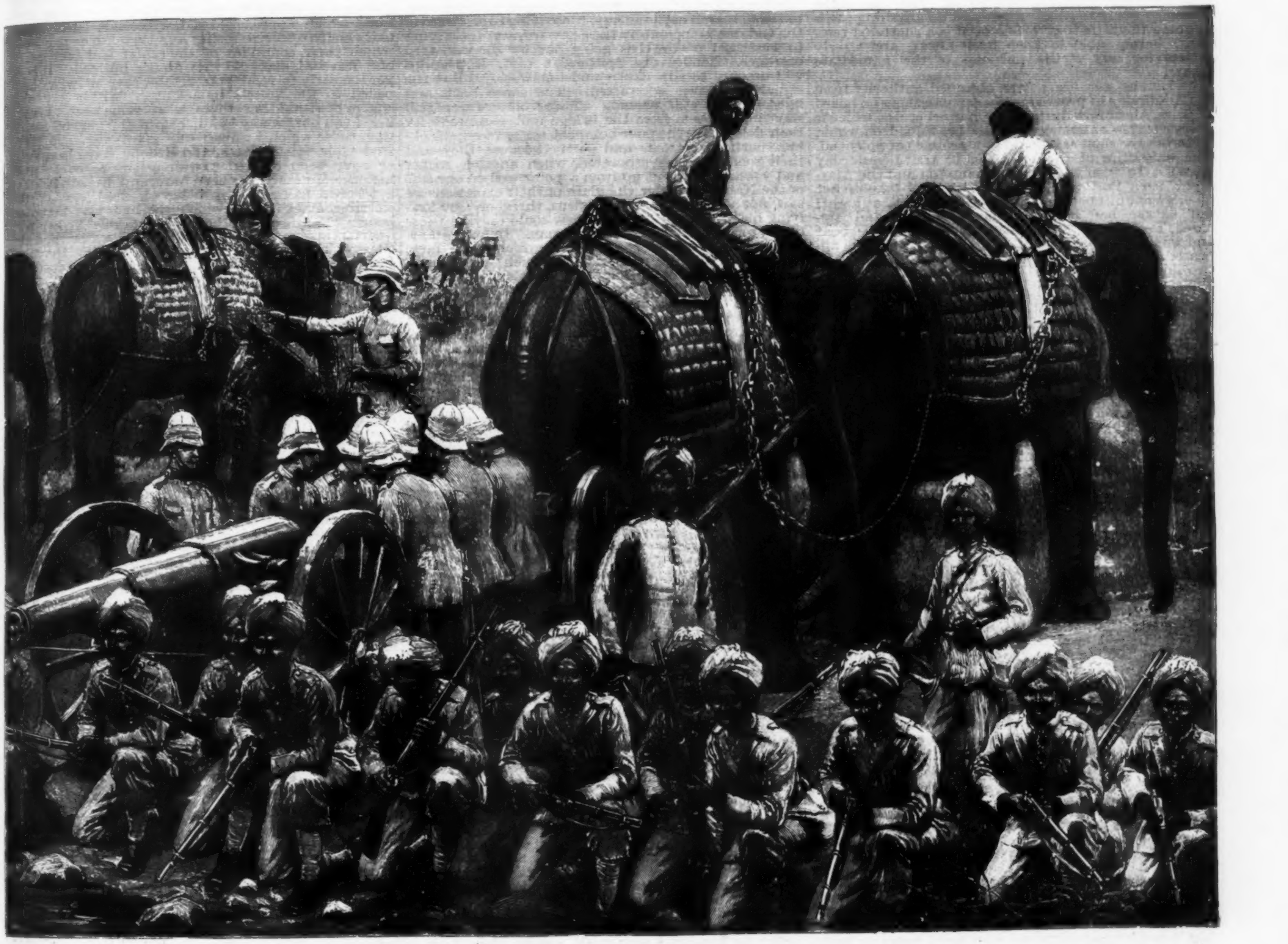
‡ Centralblatt f. Bacteriologie und Parasitenkunde, Bd. ix., No. 5.

ment had been started at that place, showed that the mice had ceased their activity entirely. In two other places, Nochali and Amarlar, a similar result was obtained. Several burrows at these places were opened and found to be empty or to contain sick, dead, or half-eaten mice. There were sick and dying mice sticking in many of the openings. A number of sick and dead mice were carried to Larissa, and examined. They were found to present all the characteristic lesions of the typhoid fever of mice, and to contain the organism in their internal organs.

Reports from other places which Loeffler subsequently received were all satisfactory. So Loeffler is justified in closing his very interesting account of his expedition with the following words: "The science of bacteriology has thus again proved its great practical significance, and hence also its right to be specially cultivated and advanced."—*Science.*

INDIAN MILITARY MANEUVERS.

OUR illustration is of an incident during a field day recently held near Secunderabad, by H. E. Sir Charles Dormer, the Commander-in-Chief of Madras. It had been raining heavily all night, but, in spite of the mud ankle-deep on the roads, the troops had rendezvoused at Bowenpally by 6 A. M., and the attacking force, having taken up a position some three miles away, were advancing on Secunderabad. At seven o'clock the order was given to advance, and by 8 A. M. the elephant battery had commenced firing on the enemy. The guns were in position on the summit of a slight eminence, which served as cover to the half company of the 15th Madras Infantry forming the guard, and also to a regiment of Sepoys and two companies of volunteers who were in reserve. Scarcely had the heavy battery opened fire before the order "Limber up" was given, and the 4th Lancers Hyderabad Contingent was seen charging up the slope. Hastily the guard sprang up from their cover, and pouring in three heavy volleys, covered the retreat of the guns. The heavy rain which came down shortly afterward prevented the march past, and put an end to the field day. Our illustration is from an instantaneous photograph by Lala Deen Dayal, of Secunderabad, Deccan.—*London Graphic.*



ENGLISH MILITARY MANEUVERS IN INDIA.

SOMNAL is the name of a new hypnotic recently discovered by a Berlin physician. Its effects are far less depressing than those of chloral, and in other characteristics it has the same advantages. So many of the new hypnotics have objectionable features, that it is a great boon to the physician to have another remedy of this class that can be used interchangeably with others and which is free from injurious effects.

[FROM THE ENGINEER.]

THE CAPTAIN OF THE MARY ROSE.*

A TALE OF TO-MORROW.

By W. LAIRD CLOWES, Gold Medalist United States Naval Institute.

III.—SOME STAGGERING BLOWS.

IN the first edition, already extensively quoted from, of its issue of Wednesday, April 29, the *Times* contained the following telegram from its Portsmouth correspondent:

"PORTSMOUTH, Tuesday, 9:30 P. M.—H. M. S. Invincible, guardship at Southampton, arrived here early this afternoon, and is now at Spithead, where H. M. S. Hero, Minotaur, Hercules, Glatton, Galatea, Latona, Iris, Bellona, Seagull, Rattlesnake, all vessels belonging to the A Division of the fleet reserve of this port, are also at anchor. The ten ships last named represent the only Portsmouth vessels that are immediately available, and several of them are not really quite fit for sea. Moreover, they are all, at present, short-handed. It may be recollected that some time ago, when the five cruisers and two gun vessels of the Australian Squadron were commissioned, the rule restricting service on the Australian station to men of five years' standing and upward was suspended in order to provide crews for them, and that, in addition, many men were taken out of the harbor ships. From the depletion which was thus caused the Royal Dockyards and the various Naval Barracks have never completely recovered; and in consequence there has to-day been the greatest difficulty in finding for the mobilized vessels even sufficient crews to take them to Spithead. Other ships could be sent thither, if only men were forthcoming. The ten warships that have been commissioned here would, to man them properly, need 2,800 officers and men. Barely 1,200 were available, and, although a few men of the Royal Naval Reserve have offered themselves, and have been gladly accepted, I doubt whether the total number of people now on board the ships in question exceeds 1,500 all told. All kinds of civilians are volunteering, but none of them are accepted pending the receipt of instructions from the Admiralty. The ships are in the meantime busily engaged in getting in their powder and shell, and work is, while I write, being energetically carried on by the aid of the electric light. All the seaward forts are manned, and many of the buoys and beacons have been to-day removed, nor were the usual lights exhibited this evening; but unfortunately the conflict between the naval and the military authorities continues, and it is but too evident that the rapid perfecting of our defensive preparations is being dangerously delayed by the fact that the local command is divided. I learn, as I close this dispatch, that the Alexandra, flagship of the Reserve Squadron, from Portland, has also arrived and has anchored at Spithead. The Hotspur from Harwich, the Audacious from Hull, the Shannon from Bantry, and the Neptune from Holyhead, are expected in the course of to-morrow, and the Iron Duke from Queensferry, the Superb from Greenock, and the Belleisle from Kingston on Thursday."

The same issue also contained the appended brief reports from Plymouth and the Medway:

"PLYMOUTH, Tuesday, 11 A. M.—The Conqueror, Achilles, Gorgon, Hecate, Prince Albert, Forth, Inconstant, Thames, Spanker, and Sharpshooter have to-day gone out of harbor, and are now anchored with the Black Prince within the breakwater. They are the only vessels at this port that are in anything like a state of immediate readiness for sea, yet they are only half manned, and there is no probability, so far as can at present be seen, of providing proper complements for more than half of them."

"SHEERNESS, Tuesday, 11 P. M.—The following vessels of the Medway Fleet Reserve, A Division, are now here, viz.: Benbow, Camperdown, Northampton, Cyclops, Hydra, Narcissus, Arethusa, Mersey, Medea, Medusa, Barracouta, Grasshopper, Salamander, Skipjack and Sheldrake. Though all of them have been officially reported as ready for sea, several—notably some of the cruisers and gun vessels—are suffering from various temporary defects, and not one is or at present can be properly manned, as neither lieutenants nor men are available in sufficient numbers. The Benbow is reported to have developed defects in her big guns, and is therefore partially useless. The Blenheim is not completed, but she may be got ready in ten days."

It was further announced that the Channel Fleet, consisting of the battleships Royal Sovereign, Anson, Howe and Rodney, the belted cruisers Aurora and Immortalité, and the small craft Curlew and Speedwell, was at Vigo, and had been ordered home by telegraph, via the Falmouth-Vigo cable. It might be expected at Spithead on Saturday morning. Most of the above quoted news was of an unsatisfactory nature; for, though the mention of so many ships as being more or less ready for sea inspired a certain vague confidence in the mind of the average layman as he sat at his breakfast table, the admission that, owing to the lack of men, half of them were really useless, was one the significance of which could not but strike even him who had only the most casual knowledge of naval affairs. To the expert the reports were still more painful, for every expert knew well enough that ships like the Minotaur, Shannon, Achilles, Prince Albert and others were, manned or unmanned, of little value save on paper. Naturally, therefore, the early morning's

* Continued from SUPPLEMENT, No. 872, p. 13931.

news, and particularly the terrible intelligence of the catastrophe off Toulon, aroused immense excitement and universal uneasiness. But excitement does not at once betray itself. Men must first meet and talk, and hear one another's views and apprehensions concerning what has happened and what is to come. And ere they had time to meet and talk on that awful Wednesday, more alarming news than had yet reached them arrived, and drove them from a state of repressed excitement into a condition of panic.

The French had struck boldly and promptly and effectively at Toulon, but not only there. Before ten o'clock a second edition of each of the morning papers announced the occurrence of a fresh and more humiliating catastrophe than that which had befallen us in the Mediterranean. The *Standard's* account is here given:

"PORTSMOUTH, Wednesday, 6:45 A. M.—While lamenting the magnitude of the misfortune that has just overtaken a great part of the fleet assembled here, and the dreadful fate that has overwhelmed I am afraid to say how many hundreds of her Majesty's officers and men, it is impossible to avoid admiring the energy and dash of an enemy who, almost as soon as war is declared, succeeds in planting a deadly blow at our very vitals. What has happened is shocking in the extreme, but it is also marvelous. With a suddenness that seems almost inexplicable, the squadron at Spithead has been practically destroyed. Late last night it seemed ready to go anywhere and do anything; this morning the little that exists of it is a shattered remnant, barely able to keep itself afloat, and utterly useless for any of the purposes of the immediate future.

"I had, as you are aware, obtained authority from the Admiralty to proceed to sea as a passenger on board H. M. S. Alexandra during the Channel cruise, which it was yesterday announced the Reserve Squadron would undertake as soon as it could be assembled at Spithead. The only ships of the squadron to arrive yesterday were the Invincible from Southampton and the Alexandra from Portland. The latter did not take up her anchorage until between nine and ten o'clock at night; but as she had been previously sighted and signaled, I—with some difficulty—engaged a shore boat and was at Spithead ready to board her when she appeared. The ships already there were anchored in two lines which stretched from the southwest nearly abreast of No Man's Land and the Horse Sand to the northwest abreast of Gilkicker Point and Ryde. The heavier part of the fleet formed the line which lay nearest to the Isle of Wight, and, beginning from the southeast, consisted of the Hercules, Minotaur, Alexandra, Hero, Invincible and Glatton. The cruiser squadron formed the line which lay nearest to the harbor, and, beginning from the southeast, consisted of the Rattlesnake, Bellona, Iris, Galatea, Latona and Seagull. There were thus six vessels in each line, the Rattlesnake being abreast of the Hercules, the Bellona of the Minotaur, and so on; and there was a distance of two cables between the ships of each line, and of four cables between the lines.

"Most of the ships, when I reached Spithead, were taking in powder and shell, and were doing so by the light of their search lights, from the hoys and barges which lay alongside. Some ships, also, were completing with coal. All, moreover, were taking in sea stores and supplies of every kind, the result being that night seemed to be turned into day, and that Spithead was crowded with boats and launches. I boarded the Alexandra as soon as she had taken up her berth between the Minotaur and the Hero; but, though it was getting late, there was, of course, no thought of turning in. Indeed, even if there had been no work on hand, and if Spithead had been as quiet as it commonly is at ten o'clock, there was so much anxiety in every ship concerning the news from the Mediterranean, and such continuous expectation that weighty intelligence of some sort would presently be brought off by one of the numerous craft from the shore, that no one cared to go to sleep lest perchance he might not hear the first word of definite intelligence. The few officers who had leisure to sit in the ward room and smoking room could talk of nothing but the war and the ships up the Straits. Those who had to be on deck thought, if they did not talk, on the same subjects. The vice-admiral and captain had gone ashore to see the commander-in-chief; the ship was in charge of the commander; and I had nothing better to do than to take stock of the scene around me.

"Alongside the Hero a hoy was hoisting out powder cases and boxes of ammunition, which were stacked around the turret on her low deck forward and thence gradually removed to the magazines below. The Minotaur was filling up with coal, and had a barge on each side of her. The Iris, abreast of us, was, like the Hero, taking in her powder, and also a number of huge electro-contact mines—great red painted iron cases which must have weighed nearly a ton apiece. We at first did nothing, but soon a coal barge came alongside, and we began not only to fill up our bunkers, but also to pile coal on our decks, for the order had gone forth that every ship was to be coaled to her utmost capacity. Usually when a ship is coaling her ports are closed, and pains are taken to exclude as much as possible the all-pervading dust; but we and the other ships were coaling cleared for action, and with half the guns loaded and run out. No vessel had her torpedo nets completely down, as all had craft alongside, but all had a certain number of boats out, and the whole anchorage between the Nab on the east and Hurst Castle on the west was supposed to be patrolled by these and by torpedo boats. A large amount of material in the shape of spars and buoys had been towed out of harbor during the day, with a view to constructing substantial defense booms within which ships might lie in safety; but the work of construction had not been begun, and most of the material was anchored on No Man's Land, where it was to remain for the night. No one, I think I may safely say, thought that there was the slightest probability of our being attacked. At midnight, however, with a view to making all sure, a couple of first class torpedo boats were sent out by each entrance, and the four were ordered to scout between Christchurch and Selsea Bill, and at the back of the Isle of Wight.

"Portsmouth, as the crow flies, is only about seventy knots—nautical miles—from Cherbourg. A vessel steaming, therefore, at a speed of fifteen knots should do the distance easily in five hours. Our enemy must have come from Cherbourg. He can scarcely, indeed, in the circumstances, have come from anywhere else; and he probably left Cherbourg at about nine o'clock, for he came upon us soon after two this morning. The sea was smooth, the night was dark and chilly, and our vitality was at its lowest, as most men's vitality is in the small hours, when suddenly, apparently not more than two or three miles from us, we heard the boom of a gun. In an instant all were on deck. Some declared that the sound had come from the east; others swore that they had seen the flash light up the sky over Egypt Point to the westward. The commander at once ordered away all the craft from alongside, and directed that the nets were to be fully rigged out; but, as every one knows, lighters and barges cannot be got rid of in an instant, and long before the order could have been obeyed, we and our satellites were in the midst of one of the bloodiest struggles of which history gives any record.

"Within a minute of the time when we heard the first report we heard others, and saw over Bembridge Point the bouquet of a rocket which, we knew, had been fired by one of our boats as a signal that the enemy was approaching in force. I am not exaggerating, and I in no way do injustice to our officers and men, when I say that a scene of the direst confusion followed. The captain of the Hercules was the senior officer present. He signaled by means of flash lights from his masthead, 'Cruisers will slip their cables and proceed with dispatch to sea in search of the enemy,' those lying to eastward of the Galatea going out by the eastward, and those lying to westward of the Iris going out by the westward entrance. Rendezvous, Spithead, 8 A. M. Battleships will prepare to slip cables and follow ——' But the signal was never completed. The shore boats and lighters were still pushing off; our officers were still shouting at them from the bridge and gangways for their delay, and the poor bumboat women were shrieking, partly from fear and partly because they and their goods had been separated, when another rocket and yet another went up from a point well on our side of the Nab, and under the glare of their explosions we saw, not a mile and a half from us, three or four low-lying black hulls, which we knew could only be those of the torpedo cruisers of the enemy. In an instant, and forgetful of our torpedo boats, which must have sent up the warning rockets, and which must, therefore, have been not far out of the line of fire, every vessel that could bring a gun of any kind to bear, opened in the direction of the foe. The roar was infernal, and, for a brief period, the dense smoke hid everything from us; but such slight air as there was gently carried the smoke to the westward, and soon we could see the enemy again. He was apparently none the worse for his reception, and was now much nearer to us. Fire was reopened and maintained with fury. The Alexandra was incommoded somewhat by the ships to windward of her, and fired only occasionally; but the Hercules, Minotaur, and Rattlesnake seemed to blaze away almost without intermission, and the volumes of smoke that came slowly to leeward showed how freely they were spending their powder. The enemy fired very little. We expected to hear him using his torpedoes. And use them he did, but not from the direction which we anticipated. That attack had lasted, I suppose, a quarter of an hour, and there had been little, if any, cessation of the firing from our side, when, to our consternation, a second attack quickly developed itself from the westward. It is quite clear to me now that the eastward attack by three or four torpedo cruisers—probably vessels of the Condor and Bombe types—was merely a feint intended to amuse us while the real attack from the westward was being made. The Needles, or westward passage to Spithead, is not a particularly easy one in any circumstances, and is commanded not only by numerous batteries, but also by the Brennan toepedo station at Fort Cliff End; but our enemies chose to take the risk of coming to grief in their attempt to find their way in by that passage, and it must be sadly admitted that the results have more than justified their temerity.

"The real attack was delivered by torpedo boats only, some being of the '*haute mer*' type, and others of the ordinary first class. The larger vessels seem to have acted as 'division boats,' and there appear to have been four divisions engaged, each division on this occasion consisting of one *torpilleur de haute mer* and three torpedo boats, making sixteen craft all told. I do not pretend to be certain either as to the exact numbers or as to the exact constitution of the force; but those who had the best opportunities of knowing place both as I have given them. The flotilla must have evaded our scouts, possibly by first making the land near Christchurch and then by keeping close under it; for it was not seen until, almost like a flash, it steamed in close order past Fort Cliff End. But Fort Cliff End and Hurst Castle were using their search lights, and it was owing to this fact that the enemy was discovered. But the forts were unprepared for instant action, and ere fire of any kind could be opened, the boats were somewhere abreast of the Bramble and within ten or twelve minutes' steam of their quarry. Even when the forts did open they did no harm, for the smoke of the action which was raging at the other end of the anchorage was drifting between them and the enemy. Besides, when the search lights from the forts, or later from the ships, fell upon any particular craft, they rendered all the other craft of the enemy completely invisible; and the operators, speedily becoming conscious of this fact, and being anxious to show up as many of the enemy as possible, shifted their projectors so rapidly as to confuse the eyes of the men at the guns. The truth seems to be that the most effective shelter under which a torpedo boat can approach to do damage is the shelter afforded by a search light played upon some other vessel by the intended victim. Moreover, very few guns could be brought to bear, the chief works being so constructed as to be almost powerless for action on the Solent side, and being mainly designed to impede the foe as he comes in from the west-southwest, not to destroy him after he has got in. Thus the French steamed up without let or hindrance to within quite a short distance of the Glatton and Seagull, which formed, as I have already said, the northeastern extremities of our two lines. These ships, or their picket boats, sighted the flotilla when it cannot have been anything like a mile from them. At the first shot from the fleet, or perhaps before it, the divisions evidently separated in order to act in accordance with orders previously given to them. Two divisions, now formed in single column of line ahead, came up at full speed between our lines. The other two divisions, disposed respectively on the port and starbord quarters of the central divisions, came up also in columns of line ahead, one on each side of the still anchored fleet. The central divisions came on therefore at a distance of about two cables from the ships on either beam of them. The other divisions kept about as far outside the lines, and the speed I imagine was fully 18 knots. As the boats executed that terrible rush through us, they were saluted with a perfect hurricane of projectiles; but they did not, so far as I know, fire a gun in reply, and I fear that a good many of our own shot intended for the central divisions must have done more harm to friend than to foe. It was fearful work; the very silence of the gray boats made the now brilliantly illuminated though smoke-dimmed scene the more impressive. One could not help admiring so splendid an exhibition of pluck, even though one was fully conscious of the magnitude and imminence of one's own peril. But there was little time for thought. Our lines were less than a mile in length. Traveling at 18 knots, a boat covers a mile in about three minutes, and in five or six minutes at the outside the dismal tragedy was begun and ended. The French launched their torpedoes with wonderful precision, the central divisions discharging both right and left, and the outside divisions, which approached a few seconds later, apparently endeavoring to rectify any mistakes or omissions which their comrades of the center had been guilty of. Too well, alas! did they do the business. It is as yet too early to send you details, save of what happened to the vessels immediately within my own sphere of vision; but there is no hope that, by waiting, I can obtain any less disheartening general results than those which I can already give you. The Hero, Invincible, Iris, Galatea, and Bellona have been sunk or have been obliged to run ashore to avoid sinking; the Minotaur has been blown up, the explosion of a torpedo having, it is believed, fired one of the electro-contact mines which she had just taken on board; the Alexandra has a great hole in her port quarter and a compartment full of water; and the Glatton has a hole in her bows. Only the Hercules, Latona, Seagull, and Rattlesnake have escaped uninjured. A torpedo, barely submerged, seems to have actually exploded in contact with the Hercules, but that ship's stout construction and armored belt saved her from anything worse than a very severe shaking. Several lighters and small craft were also sunk; and the loss of life, in one way and another, is, I fear, frightful. It is doubtful whether more than fifty of the Minotaur's people survive. The blowing up of the vessel was so violent that we, who were anchored immediately astern of her, felt as if we were jerked out of the water, and a moment later our decks were covered with and even set on fire by her burning fragments. May I never live to have another so awful experience. Limbs, ragged pieces of charred flesh, scraps of clothing, as well as wreckage, fell on board of us; and the shock of the explosion smashed everything in the Alexandra that had not already been shattered by the bursting of a French torpedo under her own port quarter. The Iris was struck just before we were, and, being in a sinking condition, was run on to the Sturbridge Sand, where she lies with her bows in two and a half fathoms. The Bellona is on the Harrow Bank, immediately under Fort Monckton. The Galatea and Hero lie sunk at their anchorages; and I am sorry to have to say that, in the struggle, a quantity of ammunition on the Hero's deck blew up, killing and injuring a number of people. The Invincible sank while endeavoring to run on to the outer Spit. The heaviest losses were suffered by the Minotaur, Hero and Galatea. The other ships have lost very few men killed, but have had a good many wounded; and in all the vessels which were torpedoed there were numerous sufferers from the poisonous and suffocating effects of the explosive gases and from shock. The Alexandra's loss is ten killed and sixty-four wounded or otherwise injured. The torpedo which struck her threw down every one on board, and raised a column of water of such volume that when part of it fell on deck it washed men into the scuppers just as if it had been a heavy sea.

"The enemy also has suffered, but very slightly in comparison with us. Two *torpilleurs de haute mer* and four torpedo boats are said to have been sunk or blown up, and of those which got away several are known to have been badly damaged. Whether our fire did any harm worth mentioning to the small cruisers which began the affair is more than we can tell. We cannot, however, claim to have done much more than destroy six little craft, and to have worked other harm which, altogether, may represent a quarter of a million. The French have done us damage to the extent of at least two and a quarter millions in money alone. They may have lost a hundred in killed and wounded; we, at the lowest computation, have lost nearly a thousand. The blow, therefore, is one the seriousness of which it would be folly to shut one's eyes to. It is, as far as the Portsmouth squadron is concerned, a thoroughly crippling one.

"That the French attack was both well designed and well carried out it is impossible to deny. It came swiftly after the declaration of war; it was so arranged as to give the attacking torpedo boats the full advantage not only of the feint from the eastward, but also of such wind as was moving; and it was designed in such a way as to place the torpedo boats, after they had done their work, in a position whence, in case of necessity, they could be rescued by their friends the cruisers. In fact it cannot be doubted that, after their wild rush through our lines, some of the boats must have been very glad to run at once under the protection of their larger consorts; for several of them were certainly badly mauled. Of our own four boats which went out at midnight to scout we have as yet heard nothing; but there is every reason to fear, as least with regard to those which were on the eastern side of the Isle of Wight, that they have been destroyed or captured. The Rattlesnake slipped her cable and followed the retreating enemy for some miles, but was recalled by the vice-admiral, who was returning from the shore when the first alarm was given, and whose steam launch narrowly escaped being run down by the port line of French torpedo boats as the vessels turned at

the head of our port line in order to rejoin their friends. The Spithead forts, I should add, did not fire during the engagement. It is rumored that they had not been supplied with ammunition. The commander-in-chief has just left harbor in his yacht, the Fire Queen, to inspect the ships which are damaged or aground, and to settle what is to be done. In the meantime the town is in a panic, other attacks being feared. The blowing up of the Minotaur broke nearly every pane of glass in Southsea, and created such alarm that several aged people are reported to have died from fright."

The second edition of each of the morning papers contained a dispatch to the above effect. The bad news, owing to the lateness of its arrival, was printed without comment: but immediate comment was unnecessary—the intelligence spoke for itself. We had been suddenly deprived of the services of five ironclads and three cruisers; which, added to the tale of vessels that had been lost or taken off Toulon, made a total of ten ironclads and five cruisers accounted for by the enemy within forty-eight hours of the commencement of hostilities.

The panic that ensued has had no parallel in the history of the country. The violation of our coasts, and indeed of our chief naval port, was an exploit which the majority of Englishmen had for generations deemed beyond the power of any foreigner or combination of foreigners; and the shock of knowing that it not only could be but had been effected threw nearly all men off their balance. The less educated classes entirely lost their heads, and at hastily summoned meetings in Trafalgar Square and elsewhere wildly denounced not only those who were, but also those who were not responsible for the disaster. It was, perhaps, difficult to apportion the responsibility among those who might be fairly blamed—among, for example, the members of the government, the Lords of the Admiralty, and the chiefs of certain departments—but it was ridiculous to blame, as many mob orators did, the admirals and captains who had been concerned. Steadier brains realized this, and their views were substantially represented on this occasion by the *St. James's Gazette*, which, in the course of its reflections that afternoon, said:

"Let us be under no delusion as to the real causes of our misfortunes. These may be easily catalogued. For years we have had naval maneuvers every summer; and all of these have been full of valuable lessons, to the majority of which we have, nevertheless, kept our eyes shut. For years we have had a large number of ships on the list of the Royal Navy; but we have not taken the trouble to make certain that the greater part of these shall always be ready for immediate service. For years we have had a Naval Intelligence Department; but we have not made it large enough to be thoroughly efficient, and we have never raised it to the level which it ought to occupy as the supreme adviser of what should and what should not be done in naval affairs. For years we have known that the French fleet at Toulon was being gradually increased, but we have never taken care that our Mediterranean fleet should be in all respects superior to it. For years we have had it dinned into our ears that divided command at the naval ports—especially with regard to coast and harbor defenses—is a source of danger, but we have not listened. For years we have been told that we were lamentably short of stokers, seamen-gunners, and, indeed, bluejackets of all sorts; but our efforts to increase their numbers have been spasmodic and half-hearted. For years we have been aware that excessively big guns were a broken reed on which to depend, but no action has been taken in consequence.

"We might extend the lamentable catalogue of our omissions and commissions, but it is useless and undignified to moan over the unalterable past. The future only is now our concern. Existing arrangements have convincingly demonstrated their feebleness and inadequacy. Some means must be provisionally adopted for properly managing the naval affairs of the empire. It may be a bad thing to swap horses when one is crossing a stream; but if one's own horse be sinking, there is no better course open. The Admiralty has collapsed; yet, although it is moribund, it still has the power to work harm. Let it, therefore, gracefully and promptly hand over its duties to stronger men. We do not blame their lordships so much as we blame the system under which they have worked. But we have no time for making compliments or considering excuses. Already we have been hardly hit. Another blow may paralyze us altogether. The safety of the country is the one thing to be thought of, and we trust that neither the Admiralty nor the public will think of anything else. To the one we recommend unselfishness and resignation to the needs of the moment; to the other, calmness, loyalty, and patriotic devotion. Ours is not an inheritance to vanish in a day, but neither is it a treasure to be trifled with."

FOOT DEFORMITY AS THE RESULT OF UNSCIENTIFIC SHOES.

By W. M. L. COPLIN, M.D., and D. BEVAN, M.D.

IN approaching the subject of scientific foot dress, one of necessity combats the traditions, experiences, and fashions of centuries. If we are to judge of the foot coverings handed down to us as relics from the courts of France, Spain, England, and Germany, we can but conclude that for an extremely long period of time, probably eight or ten centuries, the dressing of the human foot has been, even in the so-called civilized countries, but slightly different, and only in degree, from the customs of the followers of Confucius for thousands of years. Fortunately for art, unfortunately for the history of civilization, so called, the artist of olden as well as modern times has not copied, except in portraiture, the cramped foot, the narrow toe, the elevated heel, and the pinched instep which have long accompanied the human foot. It seems reasonable to suppose, however, that the Roman artist and critic, and the Grecian as well, fully attempted to give us the perfect foot as found in the well developed Grecian woman of the day. The sandals worn at the time when Rome was in her splendor were undoubtedly so constructed as to afford ample opportunity for the development of the foot, and exhibit the beauty of its conformation. The gladiators, if we are to judge of their physique by the rude representations which are handed down to us from their times, trained in extremely loose-fitting sandals, and fought their battles in "shin buskins," rarely wearing any foot covering at all.

The first criminal step taken was that of lacing the entire shoe; this error led rapidly to the pinching of the foot, and in order to retain the foot well forward in the shoe the high heel became a necessity. This is not the histological reason why the high heel was first put on the shoe, but it is evident to the thinker that, with the narrow toe worn during the reign of Queen Elizabeth, it would have been practically impossible to have prevented excoriation and severe rubbing of the heel had the shoe remained flat; hence to prevent this the heel was elevated, and the foot shot forward to the toe of the shoe, and its return toward the heel prevented by the elevation of its posterior extremity.

This can be but a brief *resumé* of the history of improper foot wear; it is sufficient to say that, as fact, the wooden shoe or the cast shoe is more conducive to maintaining the normal contour of the foot than the pinchy leather shoe.

To return to the consideration of our subject proper, aside from the influence of evolution upon the human foot, we are to remember that the foot of a child as nearly represents the ideal of a perfect foot as anything of which we can conceive; so, taking that for a basis of our observation, let us glance for a moment at the essential features in maintaining the beauty of this small piece of God's handiwork.

As briefly outlining the course which the deformity of the foot pursues as the result of improper shoeing, the accompanying diagrams are presented. They are in no sense pictures, and are made by placing the foot upon paper and carefully tracing a continuous line around it; the same is true of the shoe except that it is drawn in broken lines. It will be observed that the broadest part of Fig. 1 is at the tip of the toes, that

FIG. 1.—INFANT'S FOOT, NEVER WORN A SHOE.

Scale, three-eighths of an inch to one inch.

the toes are separated, that the pencil line can be readily made between the toes without displacing or pushing them aside. The foot is almost triangular in shape; from the tip of the little toe, a line projected backward will touch almost the entire length of the foot, and the inner margin of the big toe being continuous with the line at the side of the foot. The toes are straight, and when turned up, that is, fully extended, they will be separated from each other and evince perfect freedom of motion, both flexion and extension, in all the phalanges. The instep is well arched, both on the plantar and dorsal surfaces; the foot is pliable; and, when extreme flexion is made, it will be manifest in the arch as well as in the toe; the heel is not found extending backward; it is round from above downward posteriorly and from side to side; there is no sharp angle, and the thickening of the plantar skin begins gradually. This foot has never worn a shoe, and therefore does not show any of the evidences of the slowly developing deformity. Next we will consider the foot of a child five years old (Fig. 2). It will

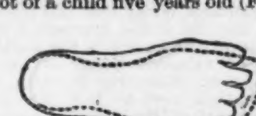


FIG. 2.—FIVE YEAR OLD CHILD'S FOOT, SHOWING BEGINNING DEFORMITY.

Scale, two-eighths of an inch to one inch.

be observed that the great toe is beginning to deflect toward its fellows; the little toe deflects slightly toward the inner side of the foot; the greatest width of the foot is no longer at the tip of the toes, but at the metatarso-phalangeal articulation; the toes can be but slightly separated by voluntary effort on the part of the individual. The toes are beginning to show slight stumping, and the overriding of the little toe and of its neighbor is beginning to manifest itself. The foot, although fat and plump, has not the smoothness, softness, and roundness which the infantile foot possesses. A line drawn from the heel along the outer or inner margin of the foot but slightly touches the great toe or the little toe at its base, and neither of them at their first phalangeal articulation. The tracing of the shoe shows exactly how the foot must be compressed in order to adapt itself to the shoe; and it is to be remembered that these drawings were made upon the outside of the shoe, and the foot must go on the inside of the covering of which this is an outside tracing. The narrowing of the toes must inevitably follow this pinching.

Passing on to the next degree, we have that of an adult foot (Fig. 3). The deformity here is sufficiently

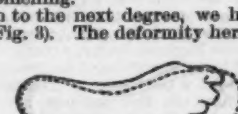


FIG. 3.—ADULT'S FOOT, SHOWING INCREASED DEFORMITY.

Scale, one-eighth of an inch to one inch.

well marked to speak for itself; a step further it becomes more marked, and reaches its climax in Figs. 4 and 5, where we have a later stage thoroughly represented. Here the great toe is overridden by the second toe, which lies parallel with the third toe; they are stumped, with nails and sides flattened. The fourth toe bends under the third toe. The bend at the first and second phalangeal articulation is angular, and both angles are surmounted by corns. The little toe bends far under the fourth toe, and at the metatarso-phalangeal junctions of the small toe and of the great toe articular enlargements are well advanced. Lines drawn along the outer and inner margin of the foot no longer touch either the great or little toe. The heel now projects backward as a result of the lacing to which the ankle has been subjected. The foot is flattened in the sole, and in some cases enlargement will be observed in the tarso-metatarsal articulation of the great or, more commonly, the little toe. These changes, as represented by the above succession of figures, are but the history of one foot, if it could be

FIGS. 4 AND 5.—ADULTS' FEET, SHOWING THE ADVANCED STAGES OF DEFORMITY.

Scale, one-eighth of an inch to one inch.

followed from infancy to adult life or later. The skin of the sole of the foot will be thick, and in no small number of cases corns will be situated either upon the heel or internal or external ball of the foot. During the development of these deformities the gait of the patient—for by this time the sufferer is a patient either of the doctor or the chiropodist—will have materially changed. Instead of the free swinging gait of childhood and youth, easily and comfortably maintained, we have now the mincing, narrow gait with evident unsteadiness in the ankles, a tendency to prevent pushing forward of the foot and a manifest effort required in ascending or descending stairs or steps. There is a poorly developed calf as a result of the heel being highly elevated. The leg is narrow and flat; the calf is deficient and the tendo-achilles prominent. Climbing stairs, or going up hills, or working bicycles or pedals, or standing on tiptoe, or dancing, tires out the calf, produces pain in the hamstring muscle and a weakness in the back. These conditions are not rarely ascribed to ingrowing toenails, corns, or a tender foot, while in fact they are the legitimate outgrowths of slowly developing anatomical deformities. Added to the improper shape of the shoe and its poor construction, we have the element of bad leather with stiff, inflexible joining, all going as important factors of the development of the deformity. The question of the arrest of these changes, the prevention of deformity, lies, of course, entirely in properly made shoes. The shoe should certainly be the same width from the metatarso-phalangeal articulation to the tip of the toe. Crowding should be prevented. The soles should be flat, no heels to jab the foot forward upon the toes. The weight should be transmitted directly to the plantar arch, and not to the ball of the foot. Stockings should be wide and not taper at the toes, having a uniform width as in the shoe from the ball to the tip of the toe; they should be seamless in the area coming in contact with the toes and soles. The texture of both the stocking and the shoe should be pliable, and neither should be worn long enough to become saturated with moisture.—*Science.*

CYCLING AND VITALITY.

IT was recently announced in the daily papers that a rider had, on an "ordinary bicycle," covered 413 miles in twenty-four hours. The feat seems incredible; and it would be interesting to know what the philosopher who predicted some thirty years ago that a cyclist could never travel faster on two wheels than he could on his two feet would think of this achievement. Anyway the thing has been done, and, what is more, there are many cyclists, men of experience in the art, who look upon it quite calmly, and predict boldly that good as this "record" is, it has been made to be beaten as certainly as it has beaten those which have gone before it.

Where is pace in cycling to end? we exclaim. Well, that is impossible to say. We know a cyclist—a member of our own profession—who declares that if he could be protected from the impeding influence of the wind and could be put on a line of railway—properly laid for the purpose—he could, if placed behind an engine tearing away at the rate of twenty-five miles an hour, keep up with the engine for one hour at least. At one of the meetings of the Society of Cyclists, over which Dr. B. W. Richardson presided, he gave a new reading to these feats. He saw in them the first true efforts leading to the practical accomplishment of aerial flight. These are subjects for the future. What we have now to do is to accept what is achieved, and estimate the cost at which the present rapid movements on wheels have been secured; the cost of vitality in the efforts of the rider, less the risk of accidents to which he is subjected.

In the month of May in this present year the value of dispatch cycle riding was put to the test, in order to show that military messages can be carried by the relay bicycle more rapidly than by horse riding. A dispatch was sent by a bicyclist from General Miles in Chicago to General Howard in New York, over a distance of 1,000 miles, with the expectation that the work could be done in 100 hours. It was done in 108 hours, time that could not have been approached by the best mounted rider on horseback. But again comes the question, At what cost? The cost to the rider is, we say at once, altogether unwarrantable, for during the twenty-four hours in which a rider is occupied in covering 400 miles his heart knows no rest from full activity, and the elastic coat of every artery in his body is in full tension. In some instances such is the tension that the man literally propels himself in what may be called blindness. His legs work automatically and his course is directed in a manner very little different,

When a bicyclist was unfortunately killed from an accident caused by fast riding, a witness said, on oath, that the rider was going so fast, and was so intent on the race, he did not hear witness until it was too late, that is to say, until he got within two yards of a cart into which he ran, when he altered his whole position, called out "Oh!" and coming into collision received the fatal injury.

In another instance, where one of the long and sleepless rides was carried out, the rider was seized with vomiting, which never ceased during the whole of the effort. He, too, lost the guiding power of his senses, and for some miles tugged on as if he were blind, tearing away, in fact, in a kind of trance, his higher nervous centers paralyzed and his body retaining its life and mere animal power, held living by the respiratory center and the heart, they also being taxed to the very extremity of danger.

When we, in these columns, tell plain and unvarnished facts of this character, we are sometimes accused of being alarmists. We care nothing for that harebrained stigma. We have our duty to perform, and it is our duty to declare, from a knowledge of the bodily powers and function, that the risk implied, even when there is escape from immediate accident, is dangerous up to the verge of insanity. We do not deny that every now and then a young man in the bloom of health and full of vital energy is able, during his short physical prime, to complete these remarkable feats and stand out for the moment the model of physical power in this one direction of it. Watching him in the plenitude of his strength, his companions will jeer at us and will ask us to tell them whether we can detect in him any demonstrable change for the worse. We are prepared to say "Perhaps no," for we have not yet at our command the knowledge and means for detecting the first and minor indications of organic injury from physical strain.

We admit, further, in all fairness, that a man may one or more times pass through the strain and not be so much injured as to be left bearing, necessarily, a life so shortened that the period of the shortening will admit of correct measurement. But with so candid an admission we must claim to hold with equal candor the facts that, although we may be unable to determine the infliction of injury by our present refined methods of diagnosis, we have the best and most common sense reasons, derived from experience, for assuming that the body at any age and in the finest condition cannot be exposed to the strains to which we refer without being oppressed beyond the bounds of safety; while we are absolutely certain that the oppression often repeated is of necessity a serious cause of organic degeneration.

On this last head experience of the clearest kind is our guide and monitor. We have watched the fate of those who, in the brief period of the history of these violent exercises of strength, have excelled and have run through their short day and generation, and we regret to record that no experience is more painful or more instructive for purposes of warning. Man is not an engine of iron and steel, but an organism of flesh and bone and blood that has to be renewed from day to day and from hour to hour, and his energy is not roughly chemical but vital in its nature; he is constructed for other and nobler purposes than mere engine labor; and if he throws himself into mere engine work, he will soon become an engine so disabled that his better self will fall into death before he has reached what in others better trained would be the prime period of vital strength and activity.—*The Lancet.*

DETECTION OF INFLAMMABLE GASES.

By Prof. Frank Clowes, D.Sc., University College, Nottingham.

The appearance of a "cap" over the flame in the safety lamp has long been used by the coal miner for detecting "firedamp" in the air, and for roughly measuring its amount. The ordinary oil flame does not with certainty detect the presence of less than 3 per cent. of firedamp. The alcohol flame adopted by Pieler detects 0·25 per cent. readily; but since this flame gives no light, the Pieler lamp can be used for gas testing only, and is useless for lighting purposes. At the last meeting of the British Association the results of an examination of the Ashworth lamp were given by the author. This lamp burns benzoline, and was found to give good illumination when the wick was raised, and to detect at least 0·5 per cent. of firedamp when the wick was pulled down until it gave a pale blue flame only.

In the present paper the author describes a miner's safety lamp, in which the ordinary flame can at once be replaced by a hydrogen flame when desired. The use of the hydrogen flame enables the miner to detect readily and with certainty percentages of firedamp varying between 0·25 and 3·0, and to measure their amount. As soon as the delicate testing is finished the ordinary flame of the lamp is kindled, and can be employed either for illumination, or, if lowered, it can be applied to the detection of percentages of gas larger in amount than those found by the hydrogen flame. The hydrogen gas is carried in a small steel reservoir, slung over the shoulder by a strap, and is introduced through a fine metal tube, which passes into the interior of the safety lamp and terminates near the wick. This composite lamp is at once a good illuminator and an extremely delicate gas tester.

Comparative experiments were made with a hydrogen flame, an alcohol flame of the same height, and a small blue benzoline flame, all of which were exposed in air containing 1 per cent. of coal gas. The "cap" seen over the hydrogen flame was nearly four times as high as that seen over the benzoline flame, and half as high again as that seen over the alcohol flame.

Many serious accidents have arisen from bringing a "naked flame" into spaces in which light petroleum oil has been stored. The vapor of this oil, when mingled with the air in proper proportions, is violently explosive, and it becomes important, therefore, to have means of detecting its presence and measuring its amount. The author described tests carried out with the above hydrogen safety lamp in his test chamber. They prove that the hydrogen flame can detect one twentieth of the amount of petroleum vapor which can be kindled in air, and one thirty-sixth of the amount which explodes when mingled with air.

Mr. Vernon Harcourt, Mr. Thomas, of Cardiff, and Profs. Barrett and Smithells, took part in the discussion of the paper, and elicited the following further facts from the author of the paper. The proportion of inflammable gas in air is measured not only by taking the height of the cap, but also by noting its appearance, which changes considerably as the percentage of "gas" rises. Further, that the size of the cap produced by a given percentage of gas is increased by the increased temperature and size of the flame. Since air containing less than 1 per cent. of this gas is explosive if mixed with coal dust, it becomes necessary to have a delicate test for gas to insure the safety of dust mines.

Thiosalicylic acid is recommended to be used medicinally for the same purposes as salicylic acid. Patents have been applied for, for a process of preparing it from anthranilic acid by converting this into *o*-diazobenzoic acid, treating with hydrogen sulphide, then with sodium carbonate or hydrate, and supersaturating with hydrochloric or sulphuric acid. On oxidation it gives at once ortho-sulpho-benzoic acid free from isomers and, therefore, important in the manufacture of the sweet substance, saccharin. —*Prof. C. Graebe, Apotheker Ztg.; Amer. Jour. Pharm.*

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